JUNE, 1891.

The Engineering Magazine.

Vol. I. No. 3.

BUSINESS OPPORTUNITIES IN HAWAII.

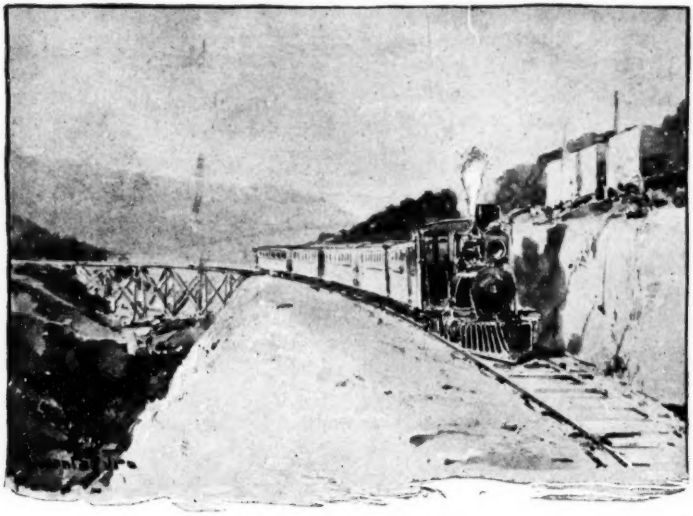
By Alenui Hau, C.E.

AMERICAN youth, as it stands related to candies, is an absorbent organism. Its properties of resistance, like those of some more advanced organisms in relation to fluids, are not essentially high and cannot be rendered so by science or art. The absorption itself has, however, its economic features. The Californian Sunday scholar who invests his nickel in the swiftly melting "rock" or "drops" in preference to placing it in the missionary box, may derive a transient comfort under his sense of moral weakness from the fact that at great sacrifice of teeth and stomach he is assisting to support the dusky Polynesian on the canefields of Hawaii.

The sugar industries of the Sandwich Islands, fostered by reciprocity with the United States, have brought great wealth to the pioneers of civilization in that little country. The output from the whole of the islands has now reached the goodly total of 120,000 tons of sugar alone. There has been considerable political cross talk upon the question as to whether this government has had a *quid pro quo* in granting reciprocity,

Copyright 1891, by The Engineering Magazine Company.

but one important point has been generally neglected in the argument, namely, that on whichever side the gold balance rests, it goes mainly into American pockets. The table given later on shows an excess of exports over imports amounting to over six million dollars. The economists of the protectionist school have sternly frowned on the export of gold to meet the excess of the sugar imports over the exports of general merchandise, but they blink the fact that Hawaii is no place to spend money in, and the colonist, as soon as he has a comfortable balance at Spreckel's or Bishop's bank



WATER TANKS ON THE HAWAIIAN RAILROAD.

takes a run over to San Francisco, Boston or New York, to "have a good time" with his savings.

There is an English minority in Hawaii, not a strong one, about which the governmental bosom suffers frequent palpitations, but they also spend more money in the States than in England. The Hawaiian flag is a kind of blend of the ensign of the United Kingdom with the banner of the United States. The Jack in the corner interferes with predominant sentiment which feels that the stripes are restless beside him and desires to see him occult gracefully behind a galaxy of stars. This is not an unlikely horoscope, but as

matters now stand, the British element in Hawaii brings considerable business to the Pacific Coast as well as profit to the islands. One of the richest English settlers has put most of his money into real estate in Cedar Rapids, Iowa, and spends a great part of his time there. British imports are handicapped by a discriminating tariff which induces English merchants to trade largely with America. All the sugar, rice and fruit raised by American, English, German or Chinese capital comes to San Francisco. All the lumber, most of the hardware and the greater part of the building material goes to Hawaii from this side. Some coal goes there from Australia, and steel rails go from Germany and England. Sugar machinery is sent there from Glasgow and San Francisco, or else it is constructed at a very good iron-works erected in Honolulu by British capital. Railway and tramway cars come almost entirely from San Francisco. Bread stuffs and feed also go from California. Liquors to a small extent are brought from France, but mainly from California.

The drift of the foregoing is that America has had in the Sandwich Islands a small but relatively profitable field of enterprise for a few of her sons with a small outlay of capital, and this is mainly due to the treaty of reciprocity. To illustrate how all the money going from America comes back to her again, let us imagine the starting of a sugar plantation. First of all the lawyer from Boston handles the conveyancing. One young gentleman who when in the law school of his New England native town earned the appellation of "necessity," because he knew no law, has developed under the genial sunshine of Hawaii into an able jurist, and with satisfaction to his clients and a comfortable income to himself carries out the transfer of the native lands. Next comes the surveyor (generally an American) to lay out the property. Then the Oregon lumberman furnishes boards and scantling for cane-flumes. The Eastern hardware manufacturer comes with the tools for clearing the bush and fixtures for the buildings. A San Francisco iron-works furnishes the machinery. American furniture is needed for the manager's house and the company's offices. Steamers built for the most part and owned in the States transport the sugar to the coast. Two American refineries there handle it and grow rich upon it. Next the groceries, fruit preserving concerns, and candy stores make their livings out of it. Lastly the irrepressible railway boy with "morning peepers" in one hand and "kyandies" in the other gets his little share of the profits of the

sugar cane. Between the relative sucking, according to their lights, of the piece of sugar cane by the little semi-nude Hawaiian, and the enjoyment of the finished candy by the Californian boy, the product of Hawaii has sweetened the lot in life of quite a variety of American citizens.

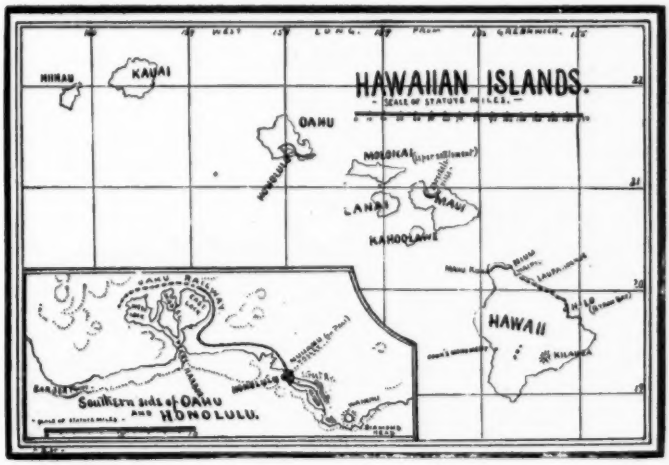
The kingdom of Hawaii, or as they love to call it, the Paradise of the Pacific, is a group of eight habitable islands and a number of rocks discovered by Captain Cook about a century ago.

Island.	*Chief Town.*	*Population.*	*Square Miles.*
Oahu	Honolulu	30,000	600
Hawaii	Hilo	26,000	4210
Maui	Lahaina	16,000	760
Kauai	Nawiliwili	9,000	590
Molokai	Leper Settlement.	3,000	270
Lanai			150
Niihau			97
Kahoolawe			63
	Total	84,000	6740

It will be seen that Honolulu, the capital, is not on the largest island. Hawaii, which gives its name to the group, can boast of a very good roadstead called Byron Bay, with a charming little town, Hilo, built round the shore. Miss Bird described it with some truth as being by nature what Honolulu is by art. But Honolulu has gone ahead since Miss Bird's time, and Hilo has remained stationary. Situated, as it is, not many miles from the foot of the famous volcano of Kilauea, it has been threatened with the fate of Pompeii and Herculaneum more than once. The lava flows of recent years have penetrated to one side of the bay, but such is the rapidity of the vegetation that what a few years ago was a stream of liquid fire is now a plantation of bananas, taro, or sweet potato-patches. When Kilauea is in full blast Hilo is kept on the jump. As many as a hundred distinct shocks have been felt in twenty-four hours. In the five months the writer spent in that region he was not fortunate enough to feel any shock at all. The houses are all built of wood, and when Kilauea becomes restive, the people put their crockery on the floor. They generally get sufficient warning both as to lava flow or earthquakes, and do not trouble themselves about it at all.

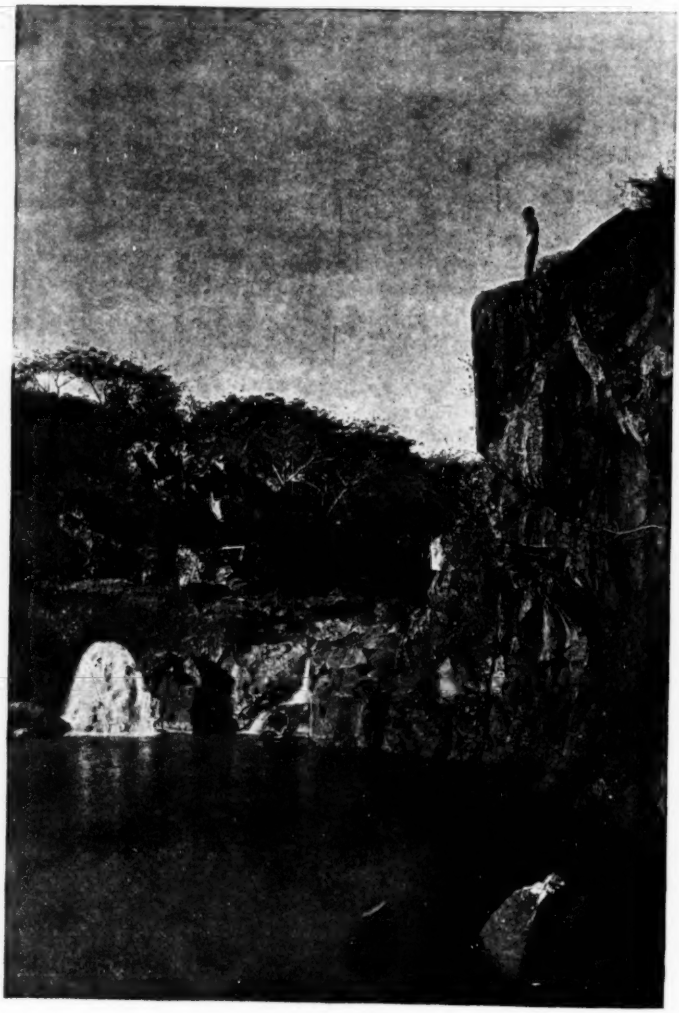
Hawaii, with its area of nearly double that of the rest of the islands put together, has not been developed as quickly on account of being furthest removed from the capital. The eastern or windward side has a chain of sugar plantations, and on the western side

there are also several of large size, but there is a great field yet for sagacious enterprise. The soil is marvellous. It produces about four times as much sugar per acre as the land of Louisiana. Fruit grows without any attention. The plantations, for the most part, have been commenced with no capital, and have had to flounder out of a quagmire of indebtedness simply by virtue of their invincible productiveness. During the late good years, 40 per cent. profit per annum was a very common return from plantations, and much greater dividends have been paid. But it is not in sugar that



MAP OF THE HAWAIIAN ISLANDS.

the best opportunities exist for developing Hawaii. The removal of the duty on sugar and the beetroot farms and sugar refineries of California are likely to prevent the Sandwich Islands from ever again reaping so golden a harvest as they did in the two last years. The settlers have for some time realized that they were making a mistake in putting all their eggs into one basket. They have been experimenting upon other products, such as cinchona, ramie, coffee, sorghum, and all kinds of fruit with great success. There is no fault to be found with the soil, the only difficulty is with the labor. Hawaiian prices are very much the same as in California, the short distance by sea maintains labor value at an equilibrium, because all

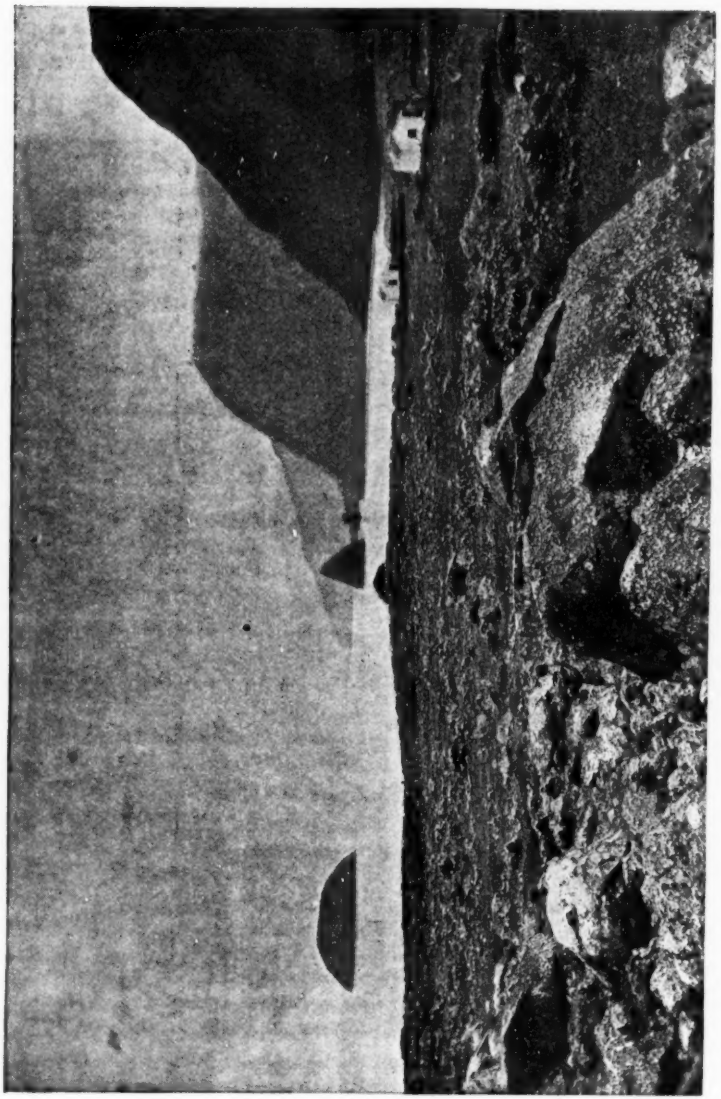


KAPENA FALLS—ISLAND OF OAHU.

but Chinese can go to America just as soon as it is worth their while. A sugar country needs coolie labor in order to compete with other sugar producing countries. In the Chinaman Hawaii had a laborer who could be imported for a wage of about eight to ten dollars per month and "find himself." He was moreover the only man who could take hold of the malarial marshes and turn them into luxuriant rice fields. Lastly he was the only man who could not ship away to the United States. But Hawaii has her strong-lunged artisan class whose grievance like that of the Californian working man is that the Chinaman can knock them out in all spheres of business by his thrift and industry, and therefore the Chinaman must go. The Japanese may be tolerated for the present. As one of the vociferators remarked to a friend of mine at election time: "There's no harm in the Jap. He dresses like a Christian, eats like a Christian, speaks plain English like a Christian and gets drunk like a Christian, but as for these Chinamen, they live on nothing, work day and night, save money, make secret societies and trusts; in fact, they are devils."

The Hawaiian is not a coolie, he is a gentleman. He can work as a laborer when he wants to and do more than two Chinamen, but he does not always want to. "Sandpaper" gin and other causes are rapidly extinguishing the native race, and the foreign trader must bear the judgment of it. But the Hawaiian is very jolly notwithstanding, and does not bear the white man any malice for extinguishing him in so agreeable a manner. He makes a good artisan and an excellent sailor, but his supreme ambition is to attain to one of the loquacious professions, for he is a born orator. He can make a nicely rounded sentence out of the word "beans." If he mounts the pulpit or stands before the judge as counsel his flow of language is prodigious; but when he takes the floor of the Legislative Assembly, he is as the bursting forth of a pent-up Niagara. He will continue until the vacated hall rings back his language, whilst the rest of the legislators smoke their cigars outside until the house is counted out. The Pearl river district is in native Ewa, pronounced Ayvah. The Hawaiian member for that district has the sobriquet of the member for *ever*, from the resemblance of his oratory to Tennyson's brook.

The best scheme for developing the island of Hawaii was set on foot by the late Hon. S. G. Wilder, Minister of the Interior, and the writer was privileged to make the surveys and estimate for it. This was a railway seventy miles long on the windward side of



LEPER SETTLEMENT—ISLAND OF MOLOKAI.

the island, to connect together the chain of sugar plantations and to bring into communication with the port of Hilo all the country suitable for fruit growing. The survey was completed, the plans and estimates prepared,—Hilo had a real estate boom on the strength of its own hopes and Mr. Wilder's reputation for enterprise. But the railway is not yet built. Hilo languishes and Samuel Gardner Wilder, Hawaii's most doughty champion, rests in the little cemetery behind his beautiful home, beneath the shade of a drooping tropical palm. There are many good men and true

WAILUKU GULCH, HILO—ISLAND OF HAWAII.

who sleep beside him; Veterans of the Grand Army of the Republic, bold navigators from the Northern Fisheries, and earnest self-denying missionaries, whose loss is commemorated by tributes of regard; but Samuel Wilder left behind him a widespread reverence for his generous heart and stalwart courage, such as no other man has left in that cosmopolitan community. By white and black, by Protestant and Catholic, by young and old he was loved and mourned. The Hon. W. L. Green, who was premier when Wilder died, said in the legislature he believed the railway which was the favorite object of Wilder's last years, would yet be built, even though it were mile by mile from one plantation to another, at the

cost of the plantations themselves, and after an eloquent tribute to the statesman's memory expressed his feeling that the railway, however built, should be called by no other name than his.

HAWAIIAN GRASS HUT.

The business of the Hilo and Hamakua coast which the railway proposed to handle, amounts to about one-third of the entire sugar output of the islands, and there is a considerable quantity of undeveloped land which could only be brought under cultivation by facilities of communication. The following tables will serve to

show the main features of the Hawaiian trade. The value per capita is $240 as compared with $23.75 in the United States.

TABLE I.

VALUE OF EXPORTS AND IMPORTS FROM AND INTO THE HAWAIIAN ISLANDS BY COUNTRIES DURING THE YEAR 1890.

COUNTRIES.	EXPORTS.			Imports.	Total Imports and Exports.	Per cent.
	Domestic.	Foreign.	Total.			
U. S Pacific Ports.	$13,021,907 34	$ 51,570 10	$13,073,477 44	$4,806,360 31	$18,332,631 80	91.19
U. S. Atlantic Ports.	.....	.....	.....	452,794 23		
Great Britain	.....	.....	.....	1,104,022 12	1,104,022 12	5.50
Germany.	.....	.....	.....	148,288 27	148.288 27	0.74
Australia and N. Zealand.	395 00	17,714 94	18,109 94	142,554 17	160,664 11	0.79
China and Japan.	193 00	12,342 85	12,535 83	277,607 04	290,142 80	1.44
British Columbia.	.....	.....	.....	13,560 00	13,560 00	0.07
Whaleships.	39 00	7,898 03	7,937 03	5,897 30	13,834 33	0.07
Islands in Pacific.	769 82	29,999 40	30,769 22	3,414 25	34,183 47	0.17
France.	.....	.....	.....	7,703 62	7,703 62	0 03
Total.	$13,023,304 16	$119,525 32	$13,142,829 48	$6,962,201 31	$20,105,030 52	100.00

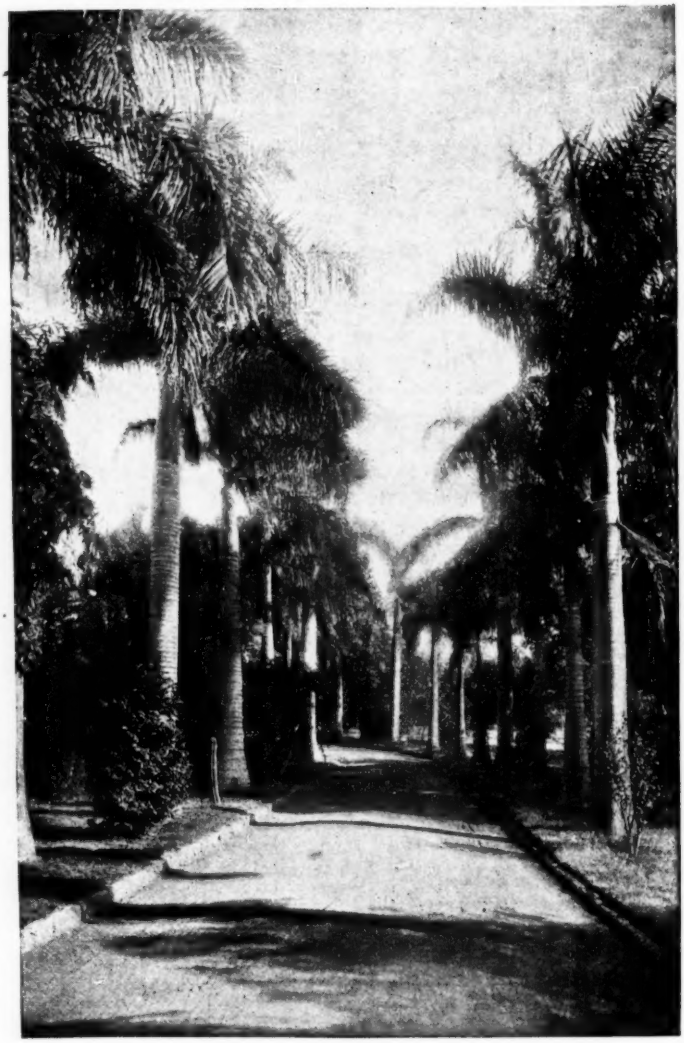
The United States received out of a trade of $20,105,030, 91.19 per cent. Great Britain and China and Japan, of all the other countries, are the only ones which figured to any extent in the commercial transactions of the kingdom, together receiving no more than 6.94 per cent.

TABLE II.

VALUE OF IMPORTS AND EXPORTS OF HAWAIIAN ISLANDS FOR TEN YEARS 1881 TO 1890, SHOWING EXCESS OF EXPORTS OVER IMPORTS.

Year.	Imports.	Exports.	Excess Exports.
1881	$4,547,978 64	$6,737,386 56	$2,189,407 92
1882	4,974,510 01	8,219,016 70	3,244,506 79
1883	5,624,240 09	8,021,843 88	2,397,603 79
1884	4 637,614 22	8,195,182 63	3.557,668 41
1885	3.830,544 58	9,069.318 01	5,238.773 43
1886	4,877,838 73	10,457,285 58	5,579,546 85
1887	4,943,840 72	9,529,447 33	4,585,606 61
1888	4,540,887 46	11,707,598 76	7,166,711 30
1889	5,438,790 63	13,874,341 40	8,435,550 77
1890	6,962,201 13	13,142,829 48	6,180,628 35
Total.	$50,378,246 21	$98,954,250 33	$48,576 004 12

It may well be said by the reader: "Surely in the face of such facts as these there should be no difficulty in promoting sound schemes for the development of such a country." The argument is



AVENUE OF ROYAL PALMS, HONOLULU.

just as true as when applied to much larger countries ; but as with them, Hawaiian progress is hampered by party strifes and private jealousies. Obstruction is not only met with from those who fear some detriment to their existing interests, but also from those who are not content with their share of the prospective benefit and hanker after their neighbor's also. Hawaii is nothing more than the world in a peanut shell.

In January, 1887, the writer was engaged by Mr. Wilder to make a report upon the existing Hawaiian railway which had been constructed by that gentleman, and to make a new survey of the windward coast with a view to extending the line from the port of Hilo to the valley of Waipio. The survey occupied five months of field work and one month of office work. It was a combination of pleasure with business such as rarely falls to the lot of the surveyor. The wild picturesque scenery of that district has been well described by Miss Bird in her "Six Months in the Sandwich Islands." Her wadings through swollen torrents and clambering of dizzy heights *en cavalier* will remain in the memory of all who have read her book. It was through this sacred retreat of Dame Nature that it was proposed to drive the iron horse.

The reason why a railway was proposed for such a region was not to make civilization but to assist it. Fully twenty years ago the virgin forest had been invaded by the planter, and now for seventy miles along that coast there is an almost unbroken belt of waving sugar cane. The beautiful valleys still nestle in their dreamy quiet between the beetling crags, draped in the wild tangle of fern and bracken and running hibiscus, guarded by stately cocoa-nut and spreading bread-fruit trees, and the shrill whistle of the engine is not heard beyond the limits of the cane field.

The two districts of Hilo and Hamakua yielded then 45,000 tons of sugar. The output is now still more. The fruit trade of bananas, oranges and pine-apples is increasing, and coffee of most excellent quality has been produced in the land not suitable for cane. There is no harbor but Hilo upon that island. A windward, rock-bound coast with scarcely any protection for even small vessels stretches with frowning battlements from end to end of the chain of plantations. Timber wharfs with derricks are erected at the foot of the precipices and whale-boats take off the sugar to schooners or small steamers which lie off shore when the weather permits. If a strong trade-wind is blowing no vessel is safe to stay there, and sometimes weeks and weeks pass and sugar spoils

while the weather-bound craft content themselves with the trade that they can get from the leeward side of the islands.

The year before the writer arrived, a fine vessel bringing general merchandise from California was lost at Wainaku, the next plantation to Hilo. She was bearing an eager bride to meet the expectant bridegroom who stood waiting on the shore. Readers will have no occasion for their handkerchiefs. No lives were lost. She only drove ashore and discharged her cargo in double quick time, after which in conscious shame, she broke up by a literal "happy despatch."

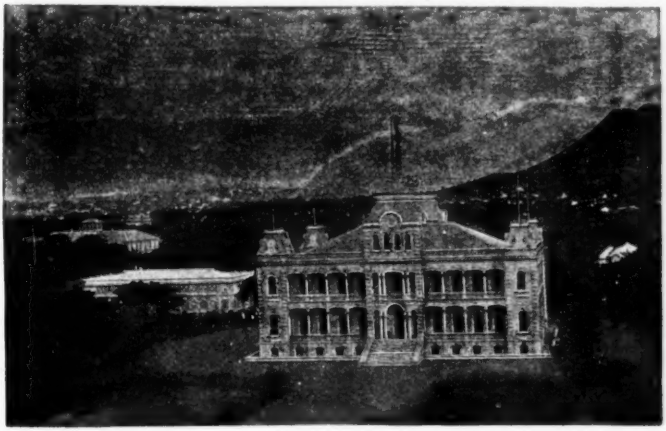
The object of the railway was to carry the output of all this dangerous coast to the port of Hilo. The engineering difficulties were such as for some time to deter Mr. Wilder and his friends from promoting it. About a hundred ravines or gulches, varying in width from a few feet to half a mile and in depth from fifty to three hundred feet, ran down at right angles to the coast line. As the railway was to be itself a coast line, connecting together all the plantations, then thirteen in number, these gulches formed barriers which had either to be bridged or "circumnavigated." The latter course was in almost every case resorted to although the result was a developed line forty per cent. longer than the air line. One or two bridges of 100 feet span were proposed, one of 120 and one of 165, but in the majority of cases the line skirted the gulch and turned the head of it with a short bridge.

The short line from Mahukoua to Niuli—termed the Kohala division—was built by Mr. Wilder about seven or eight years ago. The location was not so difficult as the Hilo line, but being carried through in somewhat of a hurry, curves of 70 and 100 feet radius were resorted to which might have been profitably eased. On the Hilo line, a surveyor who preceded the writer proposed switch-backs in nearly every one of the gulches, and a first inspection might have given any one the same impression, but careful study of each case, together with a contoured topographical map made by tacheometry, demonstrated the practicability of turning the gulches by means of curves not less than 146 feet in radius.

The map included the settlements, mill buildings, tramways, wharves and government roads. The topography was shown by contours at every five feet of height and it was from these contours that the alignment, profile and estimates were made. A triangulation survey had been made some years before by the surveyor-general, Professor Alexander, which was very useful as an occasional check.

Both the professor and his chief assistant, Mr. Curtis Lyons, are sons of the earliest missionaries. They were trained in the school of self-help and untiring industry. With very small government appropriations and frequent discouragements they have succeeded in producing work of a high degree of accuracy on similar principles to those followed by the United States Coast Survey.

For the sake of our technical readers we will devote a page or so to the methods adopted for the railway survey. It is not alone in country where chaining is impossible that tacheometry is valuable; in all rough country tacheometry is more accurate and very much more rapid than chaining. The distances and levels are obtained simultaneously and all the work is under control from the instrument. The



ROYAL PALACE, HONOLULU.

reduction of the observations is performed by the slide-rule in the field so that the position in reference to the starting point is known as the work proceeds. In surveying a gulch, the sides of which were sometimes at an angle of forty-five or even sixty degrees, there was very poor foothold for man or instrument. The rock was often rotten and one had to hold on by the strong rank grass or the guava scrub. Possibly the opposite side of the gulch on which the observations were taken would be so densely wooded that to get one sight required from half an hour to two hours of clearing with a couple of good axes. To have run a chain line would have been hopeless, but the tacheometric work when checked by fiducial points and

bench marks of the government survey was always found satisfactory and it was extremely rapid.

For flying surveys forming off-shoots from the main line, a still more rapid method is suitable, and when capable of being checked at both ends is quite sufficiently accurate for the purpose. This is performed with three instruments, an aneroid reading to feet, a pocket altazimuth and a passometer. The slide rule is invaluable in reducing the instrumental work in this as in all other preliminary survey. The non-technical traveller can learn this method in a few days. The passometer, unlike the pedometer, registers the number of paces, not the mileage. The varying value of the paces when going up-hill, down-hill, or on the level is reduced by the slide rule. The aneroid needs no description. The pocket altazimuth in its most handy and suitable form is a combination of the prismatic compass with Abney's level. The work is done at the rate of about one to two miles per hour, so that at a pinch a man can get over nearly twenty miles in a long summer day, but five miles for a day's work is generally as much as a man would care to do, and he produces as the result a topographical map which is quite of sufficient accuracy to put on record the class of country and its suitability for the purposes of construction. Practice in pacing will often bring results within one per cent., but the beginner cannot reckon on a less margin than five per cent. Tacheometry through the roughest country will produce a topographical map forming a contoured belt suitable for railway location at the rate of from half a mile to two miles per day. The accuracy should be within a quarter of one per cent.

A few words may be added in conclusion upon the other railways that are already in operation in Hawaii. One in Maui indicated upon the map, is called the Kahului railway. It was built by Captain Hobron and afterwards acquired by Mr. Wilder. It runs to Spreckelsville, the great plantation owned by the sugar king of San Francisco, and carries a large quantity of cane to the mills, of sugar to the wharf at Kahului, and of lumber and general freight to the plantations.

There are several small plantation railways on the line proposed for the Hilo and Hamakua railway; one of them was laid out by Mr. Lincoln Cabot, of Boston, on the actual location which he and the writer had adopted for the Hamakua section. It was constructed by Chinese contract labor and serves to bring sugar from a new plantation to the mill at Honokaa in that district. The work

was nearly as substantial as that proposed by the writer for the whole line, but it was done for considerably less money than his estimate, proving conclusively to his mind that those estimates of cost had been quite adequate for the satisfactory construction of the

NARROW GAUGE RAILROAD THROUGH CANE FIELDS IN HAWAII.

railway, a cost which, with the present volume of business, would have ensured a very good return to the investors.

The little town of Hilo was nearly "snowed under," if one may use such a word in such a climate, by the news that the railway would not be proceeded with. When Mr. Wilder was in London negotiating for a loan and his first efforts were frustrated by adverse political rumors, a leading Chinaman said: "Suppose that

man no come back, we all go bust." And "bust" several of the people did, sure enough.

There have been several syndicates of local business men formed to co-operate with American or English capitalists for the construction of a cable either from Vancouver or San Francisco,

A CUT ON THE KOHALA DIVISION.

but hitherto they have not been successful. The recent funeral of the king is an illustration of the great want of this cable communication. The body arrived at a city festooned with flowers to greet the living monarch, no news having reached the city of his death. But business wants are pressing all the time for these facilities. Social life becomes monotonous after awhile without news

oftener than once a month, and people who make money in the islands spend it in Europe or America where they can see and hear more of current events. A franchise was granted two years ago to the promoters of a submarine cable between the islands. This proved a sorry affair. The cable was imported but found to be too light and was therefore abandoned.

A few months will probably see the islands under a stronger management, and when a swift line of steamers plies a frequent service between Honolulu and San Francisco, and when facilities and comforts of civilization are provided equal to the demands of modern wealth, the little group of Pacific islands will probably become a winter garden and home of rest for the busy toilers of this continent.

ONE HUNDRED YEARS OF PATENTS.

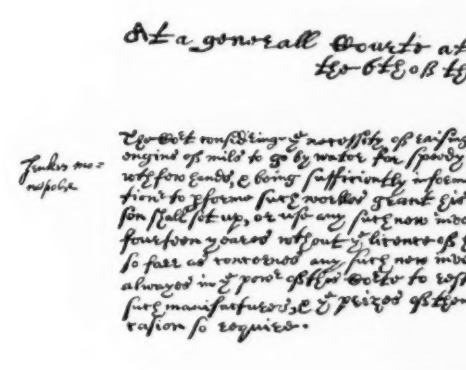
By James W. Allison.

THE recent celebration at Washington of the one hundredth anniversary of the recognition by Congress of the right of an inventor to control and enjoy, within certain prescribed limits, the creations of his brain, was an occasion of great interest to all who participated in it. The addresses delivered and the statistics presented, covering as they did the whole subject from the beginning, were both enlightening and encouraging, and affixed officially, if that phrase may be used, the stamp of truth upon the oft-quoted boast that the United States leads the world in the successful development of the arts in so far as they are dependent upon invention. Fortunately too—for it rounded out the felicities of the occasion as nothing else could have done—the International Copyright law was fresh upon the statute books, and men of letters and those of the chisel and the brush, were thus enabled, though in point of legal recognition an hundred years behind their brothers engaged in the more material creations, to add their full measure of thankfulness and congratulations to the celebration of the anniversary of the older enactment.

But the subject proper—the growth of what the politicians call "The Patent industry" of this country—is alone a great theme. That "industry" has attained astonishing proportions, and promises within the next quarter of a century to double its present most gratifying size. The complex but smoothly working machinery by which this work is done is but little understood. The inventor himself—of all men the most interested—knows it almost wholly through his patent solicitor or patent lawyer, and even each of these, whom professional duties calls frequently into the Patent Office, studies it largely as a specialist must, and with small regard to the general and generous scope of the whole. The general public is content to accept the institution in much the same spirit that it does the National Museum—with some interest in the curious things displayed there, and with some degree of gratitude at their being so carefully assorted and so well kept. But the splendid and commodious stone building, which covers two blocks between Seventh and Ninth Streets, and F and G Streets, at the cap-

First Patent in America.

Copied from the Records of the General Court of Massachusetts by
HENRY E. WAITE, West Newton, Mass., 1885.



At a generall Courte at Boston
the 6th of the 3th mo 1646

Jenkes monopolye

The Co't considringe y^e necessity of raising such manifactures of engins of mils to go by water for speedy dispatch of much worke with few hands, & being sufficiently informed of y^e ability of y^e petitio^r to pforme such workes grant his petition (y^t no oth^r p^son shall set up, or use any such new invention, or trade for fourteen yeares w^thout y^e licence of him y^e said Joseph Jenkes) so farr as concernes any such new invention. & so as it shalbe alwayes in y^e pow^r of this Co'te to restrain y^e exportation of such manifacturs, & y^e prizes of them to moderation if occasion so require.

JOSEPH JENKES, of Hounslow, Co. Middlesex, England; settled at Lynn, Mass., in 1643, where he died in 1683, aged 81 years.

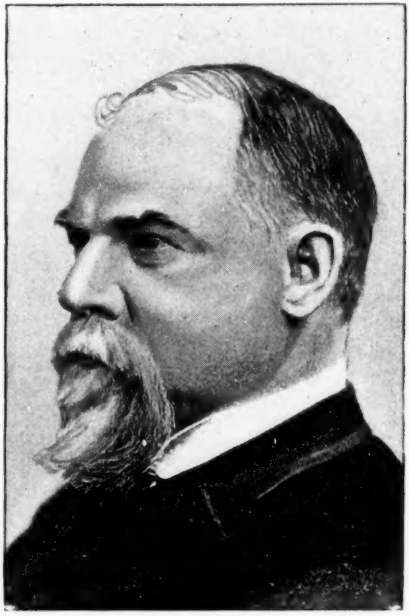
"A man of great genius." He made the dies for coining the first money; also built the first fire engine in America.

His son Joseph was Governor's assistant of Rhode Island in 1681, and built a large iron foundry near Providence.

His grandson Joseph was Governor of Rhode Island, 1727-1732.

---

ital, is more than a museum. The museum features of it are not without interest for both the thoughtful and the idle eye. There are thousands of models there—one hundred and fifty thousand in all—kept in huge cases, with glass doors opening their full length; and they illustrate as nothing else so thoroughly could how many directions the inventive American mind has taken since protection first was guaranteed to the fruits of its labor. The great fire of 1877, however, stripped the model-room of many of its attractions.



CHARLES E. MITCHELL, COMMISSIONER.

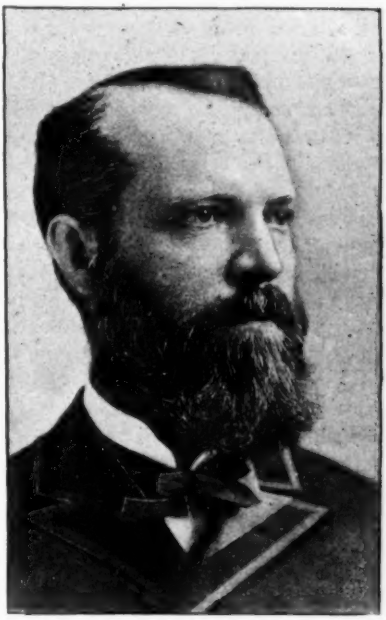
Those at present displayed there represent largely collections since that time.

But it is on the lower floors that the agencies which give or deny life and usefulness to the aspirations revealed above, are to be found. There the working force of the office finds lodgment and employment; there the copyists are ranged in one row of rooms and the examiners in another, and there the Commissioner of Patents daily receives his visitors and hears and passes upon the business laid before him.

The complaint is of long standing that the Patent Office lacks the necessary room in which comfortably to transact its business. The complaint is well grounded. The cost of the entire building in which the office is situated, aggregating over three millions of dollars, was paid for out of the Government's earnings from patents, and yet both the Land Office and the Indian Office are permitted to occupy quarters there. The result is that none of the bureaus named has room enough. This, in time, will doubtless be corrected. The Government of late years has adopted a more liberal policy with regard to public buildings, especially at the capital, and it is probable that only a few more urgent appeals in behalf of a bureau of such merit and proportions as that of patents will be necessary to insure the handing over of the entire structure now known as the Interior Department to the uses for which it was originally intended.

The present enormous business of the Patent Office has been of slow growth, but the statistics of its growth are interesting. The

beginning was discouraging. Not until the year 1836, when Congress amended the Patent Laws so as to provide for a thorough examination of all applications by men of professional acquirements, did the number of patents granted begin to show any encouraging increase. During the whole forty-six years, indeed, between 1790 and 1836, less than 10,000 patents in all were issued. The early custom however was cumbersome and clogging. Then the Secretary of State, the Secretary of War and the Attorney-General sat at their convenience as a sort of court and passed upon applications for patents. Men selected for the duties of statecraft could have but little knowledge fitting them to pass upon inventions, and so inventive genius seemed to languish. Probably Mr. Jefferson, who as Secretary of State was a member of the first board of patents and who possessed a wide range of general knowledge, was the only member of those early boards who brought to the discharge of his duties the adequate equipment for them. But the country was young then. Men were engaged in clearing the forests and opening up the vast empire to settlement. Inventive genius then manifested itself principally in the direction of simplifying and ameliorating the hard conditions of primitive agriculture. But immediately following the change in the law in 1836, and the organization of the Patent Office upon scientific lines, with a corps of trained and educated examiners to pass upon applications and a commissioner to decide and apply the law in the premises, invention everywhere exhibited a quickened spirit. Applications multiplied rapidly,



SCHUYLER DURYEE, CHIEF CLERK.

and the records of the office now show that since the year 1836 there have been issued 450,000 patents. The present year, so far, shows the greatest increase of all, and during one week in March 1125 applications were filed—the highest number for the same period of time in the whole history of the office.

There are employed in the Patent Office nearly 600 persons, and their aggregated annual salaries amount to $667,790. Another instructive item, showing the extent of the business of the office, is that over 200 lawyers reside in Washington who make a specialty of Patent practice.

In the organization and conduct of the Patent Office the principles of Civil Service Reform have so far found their best expression and strongest justification. The employés, with but a few unimportant exceptions, are all secure in their places during good behavior, and therefore do their work without the haunting apprehension that constantly hangs over those other employés of the Government who owe their appointments to political favor and may lose them any day upon the capricious turn of the political wheel. The result is the securing of thoroughly competent persons for the business in hand, and a service without material flaw and entirely without scandal.

The head of the bureau is called the Commissioner of Patents. Prior to the act of 1836, which gave the proper recognition to the bureau, he was called the Superintendent of Patents. He must be a lawyer, and he ought to be one of generous reading in his profession. It is not necessary that he be a man of scientific attainments, although if he should possess some knowledge of science as well as liberal knowledge of the law so much the better both for him and for the public. He sits almost daily in judgment on cases brought before him on appeal from the examiners, and he construes all disputed points of law. He keeps a docket, and altogether is a busy man. His salary is $5000 per annum. There is nothing political in this office, but because of its dignity and representative character the incumbent, by usage, is required to be a man in sympathy with the administration under which he is serving.

The second official of the bureau is the Assistant Commissioner, who presides in the absence of the commissioner. His salary is $3000 per annum. His knowledge of the routine of the office must be thorough, and he frequently sits with the commissioner in hearing cases on appeal. There are also a chief clerk, a law clerk, and a librarian, who complete the commissioner's staff, so to speak.

The library, it may be mentioned, is a large one, of scientific complexion, and embraces all the standard works bearing on the multiform questions presented to the office for solution.

But it is not until the Board of Examiners is reached that one finds that division of the bureau which enlists his greatest interest. By that tribunal the real difficulties are all encountered, and in some manner and measure all overcome. The decisions of the board are not final, as has already been stated, but when it is considered that the case is taken there in the rough, and all of its tangles carefully traced and its clashings with other cases pointed out, the importance of the work of the board becomes manifest.

There are, to begin with, three Examiners-in-chief who constitute a board to hear appeals from the decisions of the examiners. Then follow thirty principal Examiners, and then 160 Assistant Examiners. There are therefore, in all, 193 persons performing those duties of the Patent Office which call for superior training and a wide acquaintance with inventions. The large majority of those holding these commissions are men, although there are women so employed who are reckoned among the most capable and accomplished members of the corps. Nearly all of these people are graduates of polytechnic schools, and some of them possess varied learning. The corps, in its entirety, represents a high order of ability and education. The members, however, are removed from all temptations to embark upon ventures of their own. In accepting their places they surrender the right to pursue any investigation for their individual benefit. The law on this point reads as follows:

"All officers and employés of the Patent Office shall be incapable, during the period for which they hold their appointment, to acquire or take, directly or indirectly, except by inheritance or bequest, any right or interest in any Patent issued by the office."

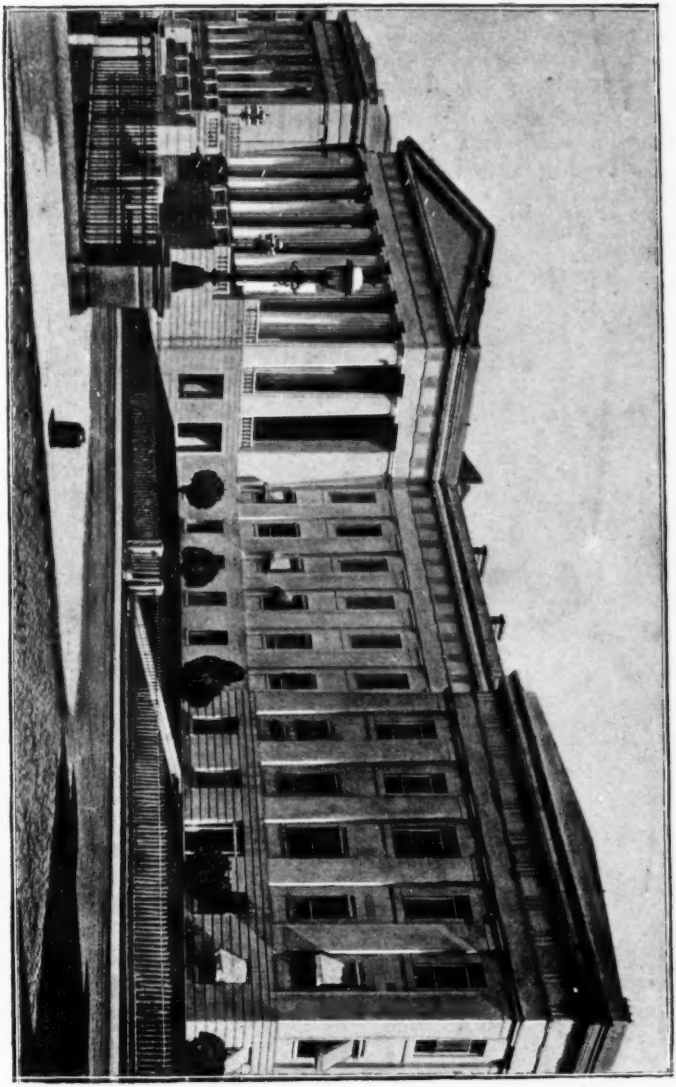
This restraint finds general approval, and, so far, implicit obedience. Benjamin Disraeli, in giving one of his novels to the public and remembering how its artificial predecessors had been lashed by the critics, spoke scornfully of those gentlemen as men who had failed in literature and art. The inventor who submits his application to the Board of Examiners of the Patent Office and receives it back rejected has no ground for attributing his failure to the envy or disappointment of his reviewers. They have never been his competitors for honors or emolument, and cannot be while holding their places under the Government. Their duties are

defined; their salaries are fixed. As a rule they have been recruited from the schools and are sustained in their work by the enthusiasm which accompanies a sincere love of learning.

The Examiners indeed, upon the more material score, have long been neglected by the Government. Their pay is shamefully small for the work they perform. The principal Examiners are paid only $2500 per annum, while the Assistant Examiners are divided into four classes, and receive, respectively, only $1800, $1600, $1400 and $1200 per annum. These allowances have not been revised since 1848. The attention of Congress has repeatedly been called to the subject, but so far without effect. The reason is obvious. The Examiners are not in politics. They have no "pull." Their appeals, therefore, are easily put aside and those of men representing votes and assistance at the polls taken up and granted instead.

The work of the day begins at 9 and ends at 4 o'clock. From 11 to 12, and from 1 to 2, interviews may be had with the Examiners by those so privileged under the regulations of the office. The work of course is all carefully classified and systematized, as is necessary from the great variety of the subjects presented and the interests involved. Each principal Examiner has his specialty and his assistants take instructions from him. To one is referred questions of Interferences; to another inventions relating to Metallurgy, Gas, Brewing, Distilling; to another those relating to Mechanical Engineering; to another those relating to Electricity, its generation and distribution; to another inventions relating to Telegraphy, Telephony, and Electric Lighting; and so on until the whole huge machinery of the office is set in motion.

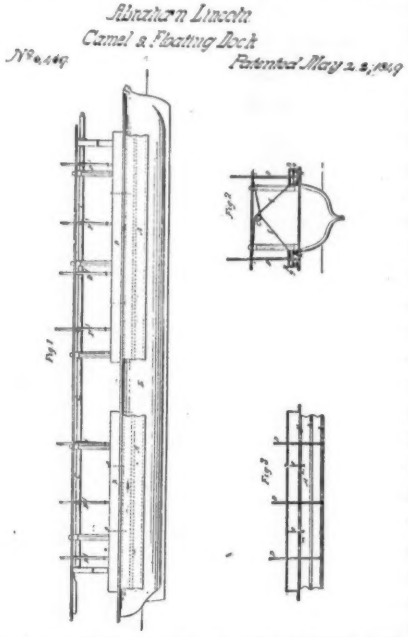
The course through the Patent Office of an application for a patent is governed of course by the nature of the application. If the invention submitted is clearly patentable, the process is a very simple one and at the same time inexpensive. The Government's fee is only $15 for the filing of an application, and the attorney's fee need not be large. If the application be allowed the patent is issued upon payment of a further and final fee of $20. The Government does not seek to make money from inventors, and the scale of fees adopted by patent attorneys is generally reasonable. Neither, in such a case, does any serious delay follow. A prompt and almost perfect system of references prevails, and so successfully is it applied that, with an examining and clerical force confessedly too small for the great bulk of the work presented, the business of the office is at the time of this writing, even in the most important and



THE PATENT OFFICE—F STREET.

complicated divisions, only two months behind. But if the invention presented is judged to have been in public use for more than two years prior to the date of the application or to have been previously invented or patented, and a contest of this contention is undertaken by the applicant for a patent upon the alleged invention, both the delay and the expense are greater.

To illustrate the case of a patentable discovery, let it be supposed that the inventor has put his application and the full description of his invention and what he claims for it into the hands of an attorney. The attorney prepares and sends the papers to the Commissioner of Patents, and upon their arrival at the Patent Office the application is duly numbered and filed and a receipt for the fee is returned to the attorney, to whom, thereafter, all communications relating to the application are made. Unless, for important and special reasons, the Commissioner of Patents give consent to an earlier examination, the application must await its turn; that is, till all previously filed applications in its class havebeen acted upon. When it is reached in due order, the specification, the drawings forming part of it, and the claims are all subjected to the closest scrutiny, because a great deal depends upon how clearly the case has been stated and demonstrated in them. This is done by one of the examiners whose branch of inquiry covers the application in question. The examination sometimes occupies several days, according to the complexity of the invention, the antiquity and present state of the art to which it pertains. If prior inven-



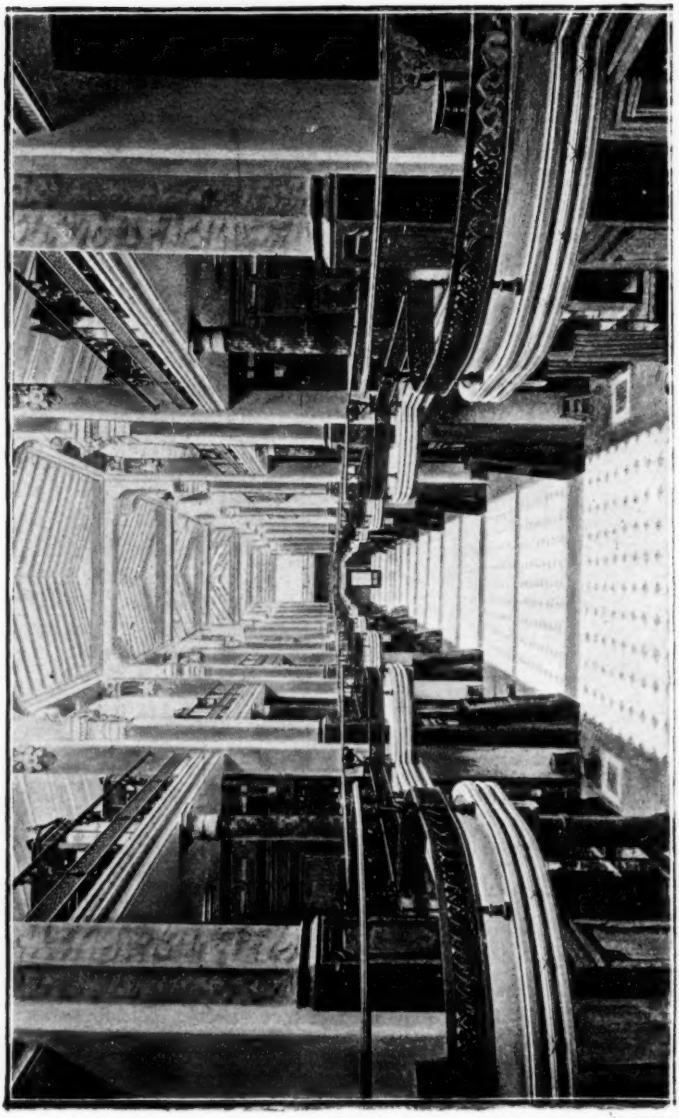
FAC-SIMILE OF DRAWING ON A PATENT APPLICATION MADE BY ABRAHAM LINCOLN, MAY 22, 1847.

tions relating to the same subject have been patented, a careful reading follows of the specifications and claims in those cases, in connection with an inspection of the drawings and models (if any) filed with them, and this not infrequently calls for the inspection of a large number of drawings and specifications. Upon the conclusion of the examination, if it be decided that the invention is patentable, the application is favorably endorsed and sent to the Commissioner and an official notice of the allowance of the application is sent to the applicant's attorney. Then upon the payment of the final Government fee of $20 (which may be done at any time within six months of the date of the official allowance) the patent is issued and forwarded to the applicant's attorney. A United States patent has a life of seventeen years, unless it has previously been patented in a foreign country. In the latter case the United States patent expires at the expiration of the foreign patent.

If, however, the Examiner decide that the alleged invention has been in public use for more than two years, or that it has been invented or patented by some other person than the applicant prior to his application, this fact is also conveyed in an official letter to the applicant through his attorney, together with specific references to the inventions or patents which are deemed to anticipate his invention. It may be, and is often the case, that such rejection is compelled by too broad claims in the application, and that amendment of the latter removes the Examiner's objections to the allowance of the application. In such cases opportunity to amend the claims is given before a final and conclusive rejection is made. Even after this has been done there exists the right of appeal, first to the Examiner of Interferences ; then, if desired, to the Board of Examiners-in-chief, then to the Commissioner of Patents, then to the Supreme Court of the District of Columbia, and finally to the Supreme Court of the United States.

The patent laws of the United States are much praised by leading jurists as in the main both just and comprehensive. There are defects, but the commissioners of late years have urged their correction and the Congress has little excuse for not having acted upon their recommendations.

The principal defects of the law as it is now, are, first, the limitation of the life of a United States patent to the expiration of a previously granted foreign patent, and, second, the opportunity the law affords for obstructing the issue of a patent to an inventor in a case that has "gone into interference" and has been decided in



THE PATENT OFFICE—HALL ON FOURTH FLOOR.

favor of his priority, by the filing prior to the issue of his patent of one or more applications embodying his invention.* The present Commissioner of Patents in his last annual report states that "it is currently believed that in some cases new parties enter the field not so much to obtain a patent for themselves as to obstruct and postpone the rights of meritorious inventors."

But the last Congress did one good thing. It provided for the appointment of two additional examiners. The request had long been pending.

Statistics do not show either the amount of money invested in this country in patent rights, or the number of persons to be classified under the term "inventors." Nor would it be an easy matter to obtain them. But the figures would certainly be large. And they are constantly and rapidly increasing. The encouragement to men who not only "give to airy nothings a local habitation and a name," but tangible form and a merchantable value, and to those who have capital at command seeking profitable opportunities, was never so great as it now is. The laws protecting patent property are strong and comprehensive, the development of the country proceeds at an unprecedented rate, and in every way and from all directions flow invitation and inducement to add something of usefulness to the general store. The response is eager and liberal. Men in every path of research and endeavor are hurrying forward with their discoveries, or with improvements on previous discoveries, anxious for a hearing and seemingly assured of reward. Many colossal fortunes have been erected upon patented inventions, and foundations for others are being securely laid. Indeed the inventor of to-day, if his discovery or invention possesses demonstrable value, enjoys such opportunity and recognition as his brother of earlier days not only did not receive but in the nature of things could not even expect. There now is an appeal to a jury of trained and just men, whose favorable verdict aids in procuring financial assistance and intellectual sympathy. The earlier inventor struggled along unaided and alone. He was a man apart, usually shunned by

*An interference, under the present law, is declared whenever two or more applications for the same invention are filed in the Patent Office prior to the issue of a patent for any one of them. The question of priority of invention has then to be decided, and if the invention be patentable, the patent is issued to the one proved to be the prior inventor. This question turns upon such nice points of evidence as who first produced the invention in practicable form; or perhaps who first made working drawings for it, etc., etc. The proceedings are often very protracted and expensive.

his more practical, thrifty neighbors who could not understand the forms and ideas he strove to express. His fate often was pathetic. He stood for all that was eccentric and thriftless. Satirists made use of him, though not to his profit. He was the butt of their flings, and as represented on the stage was a battered and ragged creature without sympathy or companionship. Even at this day a popular comedian is starring successfully in an amusing skit dealing with an inventor who with the plans of an almost priceless discovery in his pocket, is yet made to appear as the embodiment of all that is simple, childlike, impracticable and, in a man grown, exasperating. But this sorry figure is passing off the stage, and fortunately from real life. A few isolated types may be found here and there—just enough to emphasize the great change that has taken place. The spread of knowledge and the accumulation of wealth have brought appreciation and assistance for these laborers in the higher fields. They are not only "worthy of their hire," but more than ever before they are getting their pay. Capitalists no longer shun them. The rank and file no longer laugh at them. The despised of yesterday have become the prophets and the benefactors of to day.

The question has more than once been asked of the men who grapple with the forces of nature in the endeavor to give new form and use to things, what proportion bring their labors to success? The inquiry is idle. The proportion of signal successes in any walk of life is comparatively small. Of the thousands of students who throng the law schools only a small number achieve distinction at the bar. Of the thousands of men who enter the field of politics but a small number win permanent fame. In the occupation of mining the popular idea conceives men getting rich almost without effort. But of the large number who stand in the running water and sift the uncertain sands how very few ever realize a tithe of their expectations! Inventors in comparison can claim their full share of successes, and so thoroughly now are the threads they have spun interwoven with the whole warp and woof of every-day life and its agencies that the fabric would possess neither strength nor comfort without them.

AMERICAN RAILWAYS AND THEIR MANAGEMENT. *

By the Duke of Marlborough.

MY object is to give a picture of the railway question in the United States from its political aspect as regards America, and from its financial aspect as regards the foreign investor. My further object is to give a concise picture of the great resources in coal and iron of the States of Virginia and Tennessee, and to show the bearings of the railway problem on this portion of America, and demonstrate the fact which Englishmen are vaguely now waking up to realize, viz., that the great centre of industrial activity in coal and iron is going to move its centre in the course of the next decade from Pennsylvania to Virginia and Tennessee.

If any one will take a geological map of the United States and examine what I will call the geological ruins of this country, he will find that the earliest formations of archaic rocks make the continuous and unbroken rim of a huge saucer, starting in Texas, following northwards the line of the Rockies right up to Canada, thence along the line of Lake Superior across Canada and south again through the State of Maine and the Adirondack Mountains in the State of New York ; following on again through Pennsylvania to the Apallachian chain of the Alleghanies, and finishing off somewhere about Knoxville in West Tennessee. Here is the only break in the rim of the saucer, and through the opening flows the great Mississippi River down to New Orleans. The line of this saucer is naturally the line of mineral wealth. Denver, Colorado, Montana, Lake Superior, the Adirondacks, Pennsylvania, and lastly and not least, the Alleghanies, are the seats of mineral resources more varied and more important than any other portion of the world as yet inhabited by a white race. It is with the railway and mineral resources of the interior of this huge basin that I have to deal.

The South had been settled long before railways were thought of, and while the western prairies were still the unexplored home of the buffalo, English and German emigrants had settled on the whole

* Under the title "Virginia Mines and American Rails," the Duke of Marlborough contributes a very interesting paper to the April number of *Fortnightly Review*, London ; and it is from this that the extracts composing this article are taken, by permission of the Leonard Scott Publication Company.

of the fertile lands of Kentucky, Tennessee, and, away to the south, of the Carolinas. Good roads, old-fashioned country houses, and farmsteads cover these Southern States, giving to the country the same air of comfort and long-continued prosperity from an agricultural point of view that is to be seen in the old State of Pennsylvania. These early settlers did not amass fortunes by the export of grain and cattle. They simply lived and increased in numbers and in comfort, and settled down into a quiet bucolic life such as we find in many parts of modern Europe. It was not till quite recently that this portion of the United States had attracted considerable attention, owing to its marketable resources in coal and iron. The terrible war of the Secession helped to throw back this southern country in its advancing prosperity, and there was also the expense and difficulty of building railways in a country that was intersected with small rivers and of a hilly and even mountainous character. The negro question also has handicapped the South as against the North, and prevented its natural advantages receiving full appreciation. While, then, the war and the difficulties of communication cut off Virginia and the South of the central basin of North America from its share of prosperity, the North commenced its phenomenal development. The great systems of railways began to grow up, and with the railways the great towns of Chicago, Kansas City, Indianapolis, St. Paul, Minneapolis, Superior, Duluth, and a hundred other centres of commerce and railway communication. The strategical points were rapidly seized upon, and railway after railway was started under sanction of the State Legislatures and by the assistance of grants of lands from Congress itself. Many of these schemes were financed in London and on the Continent. The Erie system, the Reading, the Pennsylvania extensions, the West Shore, and many others, to say nothing of Wabash, Union Pacific, Northern Pacific, etc., are only too well-known names to the English investor. When these large railway systems were laid out and planned in America under State charters, and lands granted adjacent to the line, the schemes were bonded for immense sums, often far greater than the system cost when first opened. The promoters and undertakers floated their gold bonds in the European markets, built the roads as cheaply and poorly as they could, throwing the sleepers across the prairies and putting down the rails with no ballast but earth, and providing only wooden bridges. The English public bought the stock, enterprising financiers advertised the railway system and the ad-

vantages of the land grants in every small town of Great Britain and Germany, emigrants poured in and the land was taken up. The shares of these railways, which were in truth only worth the paper they were printed on, were forced and manipulated on every stock exchange in the world. The undertakers sold the paper they had printed besides obtaining the profit on scamping the expenditure provided by the gold bonds, and then came the era of renewals of equipment bonds, of income bonds, and all the multifarious devices of the speculator for fleecing the investing public on both sides of the Atlantic. These practices soon, however, came to be understod and appreciated in the States, and it was left to the European, and especially the English public, to find out, after bitter experience, the folly of many of these investments. It will be well to note here that this system of land grants, which was the fertile means of financing gold bonds in Europe, was impossible in the South. There were no United States lands to give away or lobby over in Congress, no grand invention of alternate sections, *et hoc genus omne* of dodges for making an undertaking attractive. The land had been granted and settled, and the State Legislatures formed from the earliest times even prior to the Revolution. Railways, then, that were twice as costly as the prairie lines, and had no collateral security of land grants, were useless undertakings to bring to London bankers and financiers. The City knew nothing of the South, and none wanted coal and iron when there was no demand for these articles. Europe wanted grain and pigs, and it was quite reasonable to expect that once the North-west was opened out and emigration poured in, these grand Northern agricultural districts would insure a return on the bonds of the railways.

I must stop here to comment on the system of financing a railway undertaking in America generally. These railway enterprises have, as I said, been always built for what are called bonds, *i. e.*, what we in England should call debentures ; and a lot of paper was then printed by the promoters which were called shares, and which really are only voting papers that have a claim to interest after the bond capital has received its dividend, and which represent what may be considered the future increment in value on the undertaking. The shares are essentially not cash. Not one penny of the money paid for them in the market was ever spent on the railway. There is nothing to control the amount of share capital a group of promoters may print. They print what they please, and they issue it as the public will buy it in the market on the specula

tion that it is going to receive a dividend, or that the voting value of the stock is worth so much for the purpose of obtaining a control of the system. Not only America, but the whole of Europe is flooded with these gambling counters which astute speculators on both sides of the Atlantic have sold the European public, and they are gambled in to-day as merrily as ever, though the majority of these shares represent no cash value at all. I do not say that this is the case with all the share stock of American railways. I do not say it of the Pennsylvania, of the New York Central, of the Delaware and Lackawanna, and of some others. I cannot, and do not wish to try, to go into the merits of different groups. I only wish to point to general conditions as they govern the methods that have been commonly practised. Almost all the great systems of railways in the States have at some time or other in their career passed through this period of private manipulation by their early promoters, and though some of them have come with honor out of the ordeal, such as the great group of the Vanderbilt lines which are settled down to-day under a secure system of control, this is not in any way the case with many vast systems which are held and financed by big operators purely for their own objects.

Let me suppose that a group of rich speculators wished to possess themselves of a powerful system of United States railways, and that, say, the Chesapeake and Ohio or the Baltimore and Ohio, had got into difficulties of one sort or another, and the stock was badly thought of by the public. They would wait to commence operations for such a moment as, say, last November, in New York, when a bear movement was knocking the best securities down ten to twenty points. Their first step would be to buy at knock-out prices the share stock of either one of these systems. They would surround their proceedings with the greatest precautions. They would endeavor to have bogus suits in liquidation brought against the corporation, and, by all means known to the financiers of Wall Street, they would break the security by publishing alarming rumors, while at the same time they would work the money market, if possible, by possessing themselves of a store of gold which they could put backwards and forwards into the market to regulate the price of the securities they were operating in. So vast are the daily dealings in such times in New York that it would not take many months before the group in question would between them have secured a controlling interest of these non-dividend-paying shares in the system in question whose affairs had got into a shaky

condition. At the next general meeting it would all of a sudden transpire that the report that had been whispered about had turned out to be true, and that such and such parties had acquired a majority of the voting stock of the company. The new interest would then at once proceed to elect its own board. Protests from the minority would be unavailing, and would entail such protracted and costly litigation, with probably no effective result, that shareholders right and left would chuck their stock on the market, and the interest in question become stronger.

The next step is to elect a president who, we will suppose, is the arch-originator of the scheme of plunder. A vice-president of the proper color is elected and a board of pawns. The organization is now complete. The original railway system may have cost millions of English and American capital in bonds. These have either defaulted and a receiver has been appointed and the railway has been sold by auction, as has often occurred with smaller lines; or it is a big system that has succeeded in keeping out of a receiver's hands, though its share capital has never paid a red cent and could, perhaps, never do so. This railway system, remember, however, runs through a magnificent country with enormous capabilities for the future in its growing towns and fine agriculture. It has connection, perhaps, with New York, or the coast; it extends to and beyond the Mississippi. It has been working its interest in with smaller lines of local importance, which it has either leased, or—and this is important—prior to the passage of the Interstate Commerce act, it has pooled its receipts with these lines on a fair and square division of profits according to mileage. Such are the properties which this financial group in Wall Street have put into their pockets.

There is, in fact, no limit to the power of a small ring in the United States who have succeeded in obtaining a control of one of the big through systems of communication, and the control once obtained, it is a simple question of time when they will be able to swallow up everything within their reach. These, then, are the stocks that the English public go on gambling in; and though they are plundered time after time, they go on speculating, and simply abuse the dishonesty of railway management in America, while the fact is they have only themselves to blame.

The people who are really to be wondered at, however, are the citizens of the United States, who continue to permit such a gigantic political abuse as this American railway monopoly to grow up as it is doing in the hands of a group of gigantic capitalists in New

York and other great towns of America. Two facts, however, are worthy of notice in this respect. In the first place, with all the abuses of financial management, the average rate per ton per mile in the United States for goods of every sort is under one farthing; while in our favored land it is over three farthings, with no greater speed in transit. We may take it as a rough statement of general average that railway freights and fares for goods and passengers in the United States, notwithstanding that wages are more than "double in America," is one-third of what it is in Great Britain. The next fact is, that where a line has anything like a decent local traffic to supplement its through haulage, any railway in North America can, and would, earn 6 per cent. on its constructive capital. The fault of the scandalous abuses in railway monopoly is not in the United States Courts, which are above reproach as we approach the Supreme Judicature, nor is the fault in the business ability of the people, for their ability and energy are far above ordinary ability in Europe. The fault is in the distressing apathy and inefficiency of Congress, and consequently indifference of the public at large. I inquired of one railway president why the system was tolerated, and why at general meetings a determined stand was not made against these financial cliques, and his answer was: "Oh, no American investor would bother himself to go and attend a general meeting to protect the public interest or his own. If his holding is small he simply dumps his stock in the market and cuts his loss." It should be clearly understood that under this nefarious system, the great strategical lines and trade routes of the country are being absorbed by irresponsible persons, and that though the value of the shares may be not worth their paper to-day, owing to the state of legislation on railway matters, some day that paper may be valued at over par. The real intrinsic value of railway stock will be as high and as secure in the long run as any form of real estate in the State itself. What the eventual working power will be of such a system as one of the great systems I have mentioned, be it the Louisville and Nashville or the Chesapeake and Ohio, or the Baltimore and Ohio, it is impossible to estimate. These lines, in their strategical importance are as valuable a property as our London and North-Western or Great Northern, etc. It is simply a question of their management, and the value of their shares to-day is not the slightest criterion of the real value they should and would possess under a more efficient and far-reaching control of Congress.

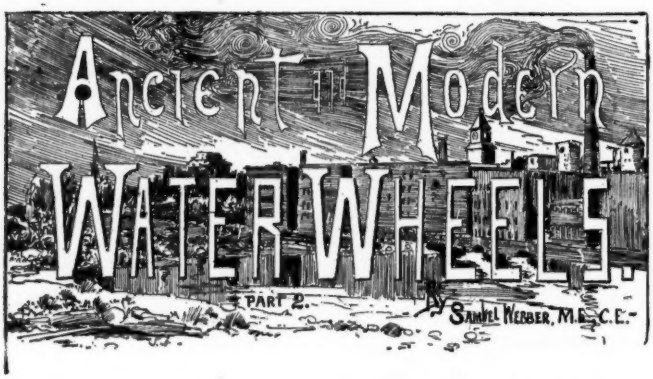
Of course, it is impossible to say the amount of harm and indebtedness that may be created by a group who obtain possession of one of these magnificent monopolies, as we know from the old histories of the Erie and the coal lands held by the Reading system. Mortgages once made have to be paid off, and this has always to be taken into account, but it must also be borne in mind that it is becoming less worth the while of great financiers now, to reckon the value of railway property as it was when the shares were only bought and sold for the turn that could be made on them in Wall Street. The hard fact is that such properties should be got hold of at all, and it is strange to consider the class of men that are growing up in America in consequence, who in their way are greater despots and wield greater power than any great mediæval baron of Norman times. I ventured to make this suggestion to a very big man in the railway world, whose Californian interests in railways amount to a great many tens of millions of dollars. "He was," he told me, "a simple man, and had no high social aspirations; it was true he had obtained great power and wealth, but he thought that on the whole it was a distinct benefit to his country that he had succeeded as he had, and that his paternal form of administration of issuing his ukases from his quiet office in New York, though it might not always suit Wall Street, was a distinct advantage to the public." Of course, he really believed this, as did the Norman Baron, when he exercised his various rights of seignieury in olden times. The only marvellous thing in the matter, besides the millions my friend could realize from a beginning that consisted of nothing, was, that the American public which prides itself on its democratic institutions should have allowed this aristocracy to grow up in its midst, which is daily becoming infinitely more powerful and infinitely more dangerous than all the feudal aristocracies of Europe put together. It was easy to get rid of the European difficulty with the guillotine as the French did, without tearing up the foundations of all social life in the country itself. In America this financial and railway aristocracy is slowly building itself into the very bone and sinew of the people, and it will be a very difficult twentieth-century problem to know how Congress is going to deal with the matter.

Railway property is becoming too valuable a form of wealth to knock about as if the shares were no better than a lot of Confederate bonds. A well-managed system of railway, with good coast communications and lying well as regards the great quadri-

lateral I have mentioned, can earn a certain profit notwithstanding the water and the burdens that former maladministration has placed on the property. It must be remembered also that reconstruction schemes have in many cases lightened the load, and whoever watches closely the policy that is being pursued on all hands cannot fail to be struck with the fact that an immense movement of steady financial development is going forward within the great railway basin of Central North America. The fact which I want to make clear here is the immense value there is in railway property iu the States, far greater than we are wont to realize. We have seen so much ruinous speculation in American railways in England, and there have been so many failures, so many receiverships; and properties have been up and down in the markets with such astonishing differences, that the English public has lost faith in American railways, and has gone in for South American and other enterprises in preference. Yet, next to real estate in the large towns of the States, railway property is probably the most valuable of all forms of wealth in America. Any railway decently managed can, and should, pay a dividend on its shares. It is a matter of certainty that every year will see this form of property gradually rise in value as large and well-considered schemes of consolidation take shape. These properties will not consolidate themselves in a day, and the abuses that have gone on so long will not at once cease, but when we look at the enormous volume of business that these railway systems control it is not difficult to realize that the wants of sixty millions of people, inhabiting one of the most fertile regions of the world, are going to surely build up a railway industry, that hardly any past mismanagement can permanently prevent from becoming a most valuable form of investment.

No one who has been to America can fail to be struck with the vastness of the railway interest of that country. It represents the very life and lungs of trade, and at the same time is the predominant factor in preserving political unity of interests between States separated by thousands of miles of intervening plains, rivers, and mountains. The management as well as the mismanagement of these vast systems is one of the marvels of that great continent. As a very observant acquaintance said to me the other day, when we were returning together on board an ocean steamer, having been over with the Iron and Steel Institute: "I went to America this autumn with my son, and we travelled over more than twelve thousand miles of railway all over the continent, and we never had

a hitch or failed to make a connection throughout all the journey." It is not a flattering thing, perhaps, to our national pride, but if the truth is told, our English railways are toy systems, and our rolling-stock are toy freight carriers, compared to the trains that are run all over America. The immense haulage of American lines done on single pairs of rails is marvellous, and these systems must continue to grow to meet the wants of increasing population and the large centres of permanent industry and manufacture that exist everywhere. It must be noted, however, that the great main arteries of these systems are now permanently marked out. It will be practically impossible to make new main routes, except at fabulous cost, with approaches to the coast. The strategical positions are seized and occupied, and whoever can possess himself to-day of a controlling interest in a main through route and allied feeders across the great central basin of the Northern States cannot be deprived of a gigantic monopoly in the present and in the future.

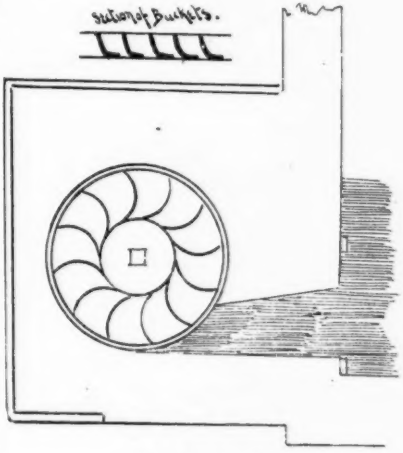


WHILE we cannot trace back the origin of the horizontal water wheel to such an early period as we can that of the vertical one, which as we have shown has been used for thousands of years for the purpose of irrigation, there is no doubt that the power of water was applied at a far distant age by an equally primitive wheel to turn the mill-stones used for grinding the grain which had been raised on the land fertilized as described in our previous article. An illustration of a primitive "Flutter wheel," which the writer saw at the Exhibition of 1851 in London, in the East Indian exhibit, is given on page 330 as a model of the primitive water wheel used in that country for ages. He has seen a similar wheel used in a New England saw-mill within sixty years, the power from which was applied to the saw by an exact reversion of the old "trundle and peg wheel," shown last month in the illustration of the Valley Forge Mill.

Glynn, in his "Treatise on Water Power" (John Weale, 1853), mentions this wheel, and speaks of similar wheels being in use for the same purpose in Asia Minor, Northern Africa, and the mountainous regions of France and Italy, where the mill-stones were attached directly to the shaft of the wheel. There can be no doubt, from its evident convenience of application, that this form of wheel was used at a very early date for this purpose. From this wheel the modern Turbine has been derived by a series of simple changes which we will endeavor to illustrate.

The first step was to put hoops around the outer ends of the vanes or float-boards, to keep the water from being thrown out too rapidly by the centrifugal action of the wheel. This made a "tub-wheel" of it, and the water was applied from above by a

sloping trough or flume. Then some one closed up half the bottom, as shown in the cut given on page 329 of the old French *Rouet-Volant*, which he says were used in the country around Toulouse. The *Roué a Cuves* (see cut below) used in the neighborhood of Metz shows a better knowledge of the laws of the motion of water, by forming the buckets with a curve instead of a right angle. These wheels are said to have given from 15 to 40 per cent. effect. Here in Alsace-Lorraine was born the Turbine. Some French engineer discovered, like Smeaton, that the whole power of water was in the weight of its column applied to the wheel, and so confined it that none of it should be lost in spray; and in order to convey it to the buckets of the wheel in the most effective manner, inserted a set of guides or *chutes* above the buckets, but curved in the opposite direction. This was shown in the Turbine built by Messrs. Fromont & Son, from the designs of M. Fontaine Baron, of Chartres, and exhibited in London in 1851. This is the type of wheel usually known in this country as the Jonval Turbine, when set in a draught tube instead of at the foot of the fall, but also called the Geyelin and the Collins' Wheel, from the makers' names. The writer has tested several wheels of this (Geyelin) pattern, and found them capable of giving from 83 to 84 per cent. net effect, at full gate; but the "plunger" gate is apt to get out of order, and the "register" gate, commonly used, cutting off the water with a sharp edge vertically to its course, breaks the flow and the "part-gate" results are very poor. This type of wheel is commonly known as the "Downward-flow Turbine," and is the direct successor of the old *Roué a Cuves*, or "bucket wheel."



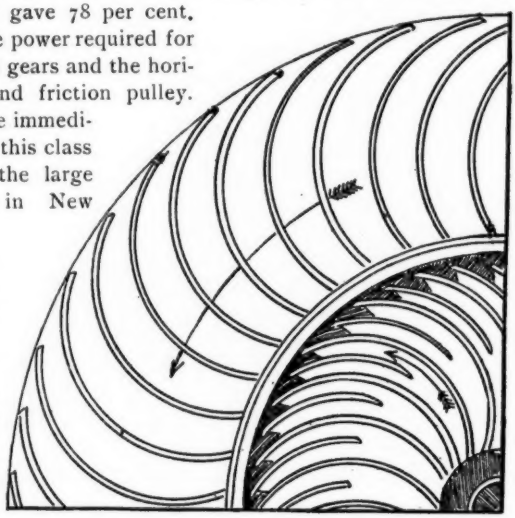
"ROUÉ A CUVES."

Another type, the "Outward-flow" wheel, was erected in 1827 by Mons. Fourneyron at Pont sur l'Ognon, which proved so

successful that in 1834 he constructed another for the Iron Works of M. Caron in Franche Comte, which is said to have worked at times under a head of only 9 inches! After constructing several others, M. Fourneyron erected one in 1837 at St. Blasier, in Baden, which has become historical. This wheel was 20 inches diameter and weighed 105 pounds, and was worked under a head of 72 feet, giving 56 horse-power, or from 70 to 75 per cent. of the power of the water expended. M. Fourneyron also erected a number of other wheels in different parts of France, under heads ranging from 6 feet 6 inches to 144 feet, which are said to have given from 75 to 80 per cent. net effect.

A second turbine was then put in at St. Blasier, from which our illustration is taken. This wheel was 13 inches diameter and 0.225 inch deep, and made from 2200 to 2300 revolutions per minute under a head of 108 metres, or 354 feet. The effect of this one is said to have been from 80 to 85 per cent. It used about one cubic foot of water per second, which was all filtered before delivery to the flume.

The result of these wheels attracted the attention of American engineers, and in 1844 the late Uriah A. Boyden, of Boston, constructed a Fourneyron turbine for the Appleton Mills at Lowell, of 75 h. p., which gave 78 per cent. effect, *beside* the power required for a pair of bevel gears and the horizontal shaft and friction pulley. This led to the immediate adoption of this class of wheels by the large cotton mills in New England, instead of the cumbrous Breast Wheels then in use, and the Fourneyron wheel is still built to some extent, but from its great cost (being a *built*



SECOND FOURNEYRON TURBINE, AT ST. BLASIER.

wheel) and poor efficiency at "Part-Gate," has been generally superseded by cheaper and at the same time more effective wheels.

The first step in the present direction was made by Samuel B. Howd, of Geneva, N. Y., who, in 1838, patented a horizontal wheel in which the motion was reversed, the gates and guides being outside the wheel and the discharge toward the shaft. This was the first "inward discharge" wheel, and it afforded much better facilities for regulating the gate opening so as to give an unbroken current of water on the wheel.

In 1851 an improved form of this wheel was also designed and tested by Mr. Francis, at Lowell, giving 79 per cent. net effect. In the meantime other people had been at work on turbines. In 1843 Mr. Ellwood Morris, an eminent engineer of Philadelphia, published in the *Journal of the Franklin Institute* a translation of "Morin's Experiments on Turbines," and also an account of experiments made by himself on two turbines of his own construction then in operation near Philadelphia.

I have not the data nor the space to give an account of the various experiments on horizontal wheels made in this country down to about 1859, when A. M. Swain, of North Chelmsford, Mass., designed and constructed a turbine combining the principles of the inward and downward flow, which has been the prototype and original of the best turbines in use at the present day.

THE SWAIN TURBINE.

One of these wheels, tested by Mr. Francis at Lowell, gave 84 per cent. net effect, and this result, combined to the less cost of the wheel, led to their adoption in Lowell as the Boyden wheels wore out. The cut given not only shows the general form of the wheel but will serve with slight alterations to illustrate the general form of turbine giving the best results to-day; the principal changes being in closing up the central discharge. The union of the wrought iron or brass buckets with the cast-iron body of the wheel was, however, imperfect and led to many accidents, and this brought about the change to a still cheaper wheel, which was either cast at once solid by the use of suitable cores, or had cast iron buckets bolted in. The latter form, however, has been little used, and many of the best wheels to-day are cast in solid bronze.

To show the extent of the turbine business, I might mention the

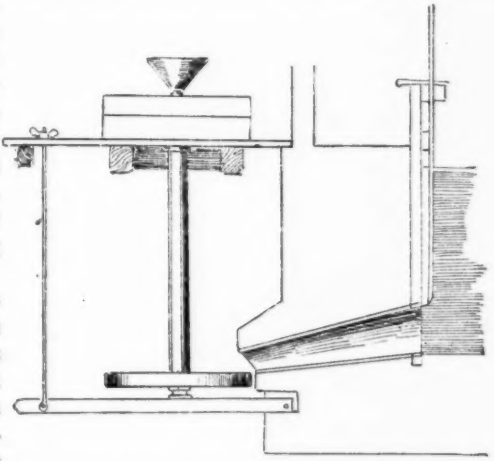
names of some of the prominent builders which occur to me, and there are many more which I do not recall, viz. : John Tyler and Sullivan Machine Co., Claremont, N. H. ; Humphrey Machine Co., Keene, N. H. (Excelsior Wheel) ; Rodney Hunt Machine Co., and Chase Turbine Co., Orange, Mass. ; Lowell Machine Shop (Boyden Wheel) and Swain Turbine Co., Lowell, Mass. ; Holyoke Machine Co. Holyoke, Mass. (Hercules Wheel) ; Kilburn, Lincoln & Co., Fall River, Mass. (Fourneyron Wheel) ; I. T. Collins, Norwich, Conn. ; R. D. Wood & Co., Philadelphia (Geyelin Turbine) ; S. Morgan Smith, and York Mfg. Co., York, Pa. (Success Turbine) ; T. H. Risdon Co., and T. C. Alcott & Sons, Mt. Holley, N. J. ; Robt. Poole & Sons, Baltimore, Md. (Leffel Wheel) ; Jas. Leffel & Co., Springfield, Ohio ; Dayton Globe Iron Works (New American), and Stillwell & Bierce, Dayton, Ohio, (Victor and Eclipse Wheels) ; Gates Curtis, Ogdensburg, N. Y. Of these the "Leffel Wheel" has probably been the best known and most widely popular of any turbine ever built, but the tendency to day is to downward discharge wheels with fewer buckets, wider openings, and longer curves. The general impression is that the turbine is best suited for low heads of water, and this may have been the case with the original Jonval or Fontaine wheels, where the whole weight of the water bore on the step at the bottom of the vertical shaft, but this is all obviated by the modern system of setting smaller wheels in pairs on a horizontal shaft, and allowing the *thrust* of one to neutralize that of the other. This entirely does away with all the objections to high heads, and the writer knows of turbines so set running successfully under a head of 150 feet, and has himself planned them for a head of 50 feet.

In fact he claims to have been the first one himself to set regular turbines in this manner, having placed seven small wheels in this way in the Manchester Print Works, at Manchester, N. H., about thirty years ago, or about the beginning of the late Civil War ; but he took the idea from a "Parker Scroll Wheel" set in the same manner with a draft tube.

This invention of the "draft tube," which has been of very great importance to the turbine and has made horizontal shafts possible, was patented by Zebulon and Austin Parker, of Licking, Ohio, June 25, 1840, and although it is used in France on the Jonval turbines, the writer does not know the date of its introduction there. The "Archimedian Scroll Wheel," or "Whitelaw and Stirratt Motor," was set on a horizontal shaft by Prof. Redtenbacher,

of Carlsruhe, in Baden, before 1853, and both horizontal shafts and draft tubes are commonly used by the best turbine builders to-day.

Suffice it to say that with these modern improvements there are half-a-dozen turbines at least on the market which can be relied upon to give over 80 per cent. net effect under any available head, and the turbine has superseded the old breast or overshot wheel in the United States almost universally, from its great cheapness in first cost and economy of application. Since writing the previous article on the latter class of wheels, the writer has received statements from the Pelton Water Wheel Co. of San Francisco, showing an effect of 87 per cent. from their wheels under the enormous head of 450 feet, and as they seem to be supported by good authority he cannot dispute them, although they far exceed his first impressions formed from a drawing of the wheel.

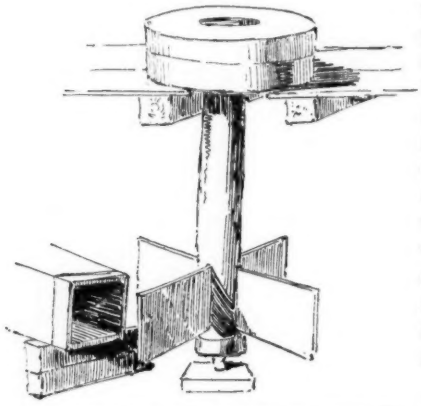


ELEVATION—"ROUET-VOLANT," FROM GLYNN.

The curiosities which have come under the writer's notice in the last twenty years in the way of turbines are almost innumerable and certainly amusing. "Double action" and "back action" wheels with angles where there should have been smooth curves; and one wheel delivering water to another running in an opposite direction; all supported by the highest authority in the shape of certificates from village mayors and country schoolmasters, some of them stating that they saw Mr. Blank's wheel give 175 per cent., and think it would give 200 per cent., are among them. The fact is that every free-born American citizen considers it among his unalienable rights and privileges to invent a patent medicine and a water wheel, and he usually does both with equal ignorance of and indifference to the laws of both hygiene and hydraulics!

Probably from their lack of water power, perhaps from its being of French origin, the English have never taken kindly to turbines, but they were at once adopted in the United States, and their effect in developing and utilizing our numerous water powers has been invaluable. In fact a large number of the best American turbines have been sent to England where they have given great sat isfaction.

I have spoken of the great variety of turbines which have been built and which have played their part more or less in utilizing the widely diffused water power of the country, but as that water power becomes more valuable, the poor wheels are gradually "sifted out" and the value of the wheels is determined by the measurement of the power received and that of the water employed. The first measurement is very simple and consists merely in the application to the wheel shaft of a "Prony Brake," well known to engineers, while the water is at the same time measured by ascertaining its depth as it falls or flows over a sharp-edged weir.



OLD EAST INDIAN GRIST MILL, EXHIBITED IN LONDON, 1851.

We do not propose to follow the eminent engineers who have been following up this question for 100 years into any of the calculations or formulæ which they have used, but may simply state that the quantity of water discharged over such a weir varies as the square root of the cube of its depth, or that approximately in round numbers, if the depth of the current is doubled the quantity of water is nearly trebled.

Mr. Jas. B. Francis, the eminent hydraulic engineer of Lowell, Mass., by experiments on a large scale made forty years ago, determined the quantity of water delivered over a weir 1 foot wide and with the water 1 foot deep, to be 3.33 cubic feet per second; but if the water was 2 feet deep, it was 9.4187 cubic feet per second.

Now this 3.33 cubic feet multiplied by the length of the weir and by the square root of the cube of the depth or height of the

water gives the total discharge, and this is the measurement by which all turbines are tested. If the water is contracted at either end of the weir, one-tenth of its depth is subtracted from the length for each such contraction.

The Holyoke Water Power Co. at Holyoke, Mass., have built a very complete testing house and apparatus, fully described by Professor Thurston in several of the Transactions of the Society of Mechanical Engineers, in which all the turbines intended for use in the mills at Holyoke are tested before being put in place, at various openings of gate, and the water used by the mills is afterwards ascertained by daily examination of these gate openings, thus making the turbine a Meter as well as a Motor.

Running streams are also measured in this way, as shown in our cut, care being taken to measure far enough back of the dam to avoid the curve which precedes the fall. We had intended in this connection to say something about the extent and value of the water powers of the United States, but the subject is so large that it would require a separate article. It may, however, be said that many of them have been made valuable by the turbine, which has been of great use in falls, either so low or so high as to make the old breast or overshot wheels inapplicable; and it may further be said that while for very low heads large wheels of the Jonval type seem best suited, for very high heads small wheels in pairs on horizontal shafts are preferable.

THE IMPORTANCE OF GOOD WAGON ROADS.

By Prof. Lewis M. Haupt, A. M., C. E.

IT is a platitude to say that the roads are bad. Every one concedes the fact and at once concludes that it is best to accept the inevitable. As the obstruction to commerce is general and affects all classes, all are content with the situation and prefer the indifferent policy of bearing the ills they have rather than make any effort to remove them.

Nothing is done because of the current belief that improved roads cost more than those which are maintained in a state of nature, and it requires a careful analysis of facts to convince a community that this is an error.

It is frequently asserted that there is no tax so onerous as that due to bad roads, and yet it would seem that the farmer would prefer this heavier burden to the lighter one because it may not involve on his part an immediate outlay in hard cash, or he may console himself with the thougnt that he may escape the losses due to bad roads by biding his time and doing his necessary hauling while they are good. This is a delusion, for the time lost by such delays or the accidents caused by his having to move during a rainy period will sadly upset his complacency.

The loss of a horse is not a subject which is of sufficient importance to attract public attention even when it is traceable directly to bad roads. The obituary is to be found in a few obscure lines of a local newspaper, yet it may involve a serious loss to the farmer and cripple his work for the year.

In Chester County, Pennsylvania, where the road movement has made some progress, two valuable horses were recently destroyed by the roads within one week. The first instance occurred on March 21, when one of the leaders of a six horse team employed in hauling a load of hay stumbled and fell in crossing an overflowed road, and "*before he got up he was drowned.*" Again, a week later and only a few miles from this point another animal sank in a quicksand in the road and was suffocated before he could be gotten out.

In the same month, March of this year, a lady of Maryland recovered $2500 damages for personal injuries from the commissioners of Montgomery County by reason of the bad roads, and the

awards and costs will make the sum which the county will have the privilege of paying aggregate $4000. But even this sum is no equivalent for a lifelong injury.

It is no uncommon sight to observe from four to six pairs of mules employed to do the work of one, and on the plains the writer has seen eight yoke of oxen hauling less than a cord of wood.

Within a few miles of the "City of Brotherly Love" a contractor agreed to haul a boat load of salt hay weighing thirty-five tons for a distance of seven miles, four or five of which were over the earth roads of the city. It was expected that this hauling could have been done in three days at a cost of fifty dollars; but the roads being hub-deep in mud it was found that it required two weeks and cost two hundred dollars, while the horses were nearly "used up." This was more than the whole thing was worth, and put a stop to the business.*

Thus, instead of costing twenty cents per ton-mile, which is about the usual rate on an earth road in good condition, it actually cost eighty-two cents per ton-mile, due to the mixture of earth with water.

Many other cases of waste and loss might be cited, but there is no need of multiplying instances, which may readily recur to every reader, as evidence that the roads or streets are in a bad condition. At best, words are so vague that instructors are obliged to have recourse to the object itself or its graphic representation. Hence the tendency to illustrate actual phases by photographs which is so greatly facilitated by the dry plate process.

Many persons will see defects in a picture which would not be observed in nature, where the impression is dispelled by other effects. Thus one of the most common evils of a street pavement and the cause of many accidents is the gauge rut often noticed by the close observer. The cause of this defect is the absence of a suitable foundation, as most pavements are laid directly on the clay subsoil or upon rubbish or so called gravel, containing too great a percentage of clay or loam. In foreign cities where the traffic is heavy or the grades are steep the "sets" are laid upon a concrete base. But in these cities the service pipes are already laid, and there is consequently no necessity for continual irruptions as in the adolescent cities of the New World where the pavements are so designed as to be readily removed or disturbed, even by natural agencies. There are cases on record where the entire street has

*Vide "A Move for Better Roads." H. C. Baird & Co. Philadelphia. $2.

been appropriated by the contractor, with the sanction or through the neglect of the municipality, and where all approach by vehicles to the dwellings or shops fronting thereon, has been suspended for weeks.

A striking illustration of the long-suffering patience of a *laissez faire* community is shown in a photograph taken on Bainbridge Street, below Fifth, in Philadelphia, opposite the old market sheds, which in consequence of the neglected condition of the work has been made a dumping ground for garbage, dead animals and market refuse, rendering the neighborhood redolent with odors.

These local obstructions and interruptions are unquestionably serious burdens, but they will not in the aggregate equal in amount those imposed by the roughness of improperly paved streets. The resistance to traction offered by a rough and irregular surface constitutes one of the most serious taxes imposed upon commerce, although it is one not fully appreciated.

In the larger cities like New York or Philadelphia the loss due to this cause is estimated to cost the community over fifteen million dollars annually, while the extra cost of hauling over country roads is even greater in amount though less in extent. It is a moderate estimate that places the cost of hauling over country roads in fair condition at twenty-five cents per ton-mile, while for similar freight moved over a railway the cost is in many cases as low as one-half of a cent or less, that is, one-fiftieth. By navigable rivers or lakes the cost may be still further reduced to one-fourth of a cent, and by ocean transports to one-eighth. These rates furnish the best measure of the cost of overcoming the resistances which impede the flow of commerce and illustrate the great value of reducing them to a minimum at the outset in opening a new line for heavy traffic. There is no system more extravagant or wasteful of the resources of the producer than the mud roads, and it reacts on all classes in succession. The transporter, the manufacturer, the agent or middleman, and the consumer must all pay for the wear and tear of hauling through mud, or the interest on the value of the raw material while awaiting a favorable time for transportation.

It is manifest that the consumer must pay the cost of production and of transportation on all the articles he requires. The latter item is often the larger part of the cost and frequently so great as to limit the distance to the market. Every article has a specific market-range depending upon its facility for reaching the place of consumption. This range is determined by the product of the two

factors, distance and rate per mile. When this product is equal to the margin between cost of production, commissions and selling price, it fixes the limit for the market-range. But if the rate per mile by roads can be reduced, as it undoubtedly can be with great profit, the range is correspondingly increased. If it be made one-half, the distance may be doubled and the theoretical areas of supply and demand be quadrupled.

The great national benefits resulting from this general principle in reducing the cost by increasing the facilities of traffic, have been very admirably stated in the contribution entitled Highways and National Prosperity, by Edward P. North, C. E., as published in the April number of this magazine, wherein the importance of the waterways is more particularly set forth.*

The problem of road building is one of overcoming or reducing the physical resistances due to grades, curvature, friction and rugosity, or briefly of finding the line of least resistance. It is an engineering problem of a complicated order and has nothing to do with politics, and yet the laws which have been framed to regulate the construction and maintenance of our highways seem to have been designed to distribute political patronage and to encourage a continuous drain on the treasury without satisfying the requirements of the problem. It is utterly useless to proprose an improved road system under existing laws and methods of supervision. Realizing this, many States are assiduously striving so to modify their road laws as to secure intelligent and competent supervision. The New York law passed June 7, 1890, provides under this head that "All improvements and repairs made under and in pursuance of this act shall be done under the supervision of a competent civil engineer, holding a diploma as such, to be appointed by the board of supervisors, and to be removed by vote of four-fifths of all the members of the board,—etc."

The bill proposed for Tennessee provides first, that there shall be a State Engineer ; second, competent County engineers ; third, competent foremen or road-masters to be appointed by the County Engineer for every few miles of road.

Similarly the bill drafted for Maryland provides for the appointment of a State Engineer by the University with County Engineers selected by the State Engineer.

*For some additional facts relative to canals and their relation to transportation by the writer, see Proceedings American Economic Association, July, 1890. Johns Hopkins Univ., Balto., $1.

In Pennsylvania the State Road Commissioner recommended merely that there be a County Engineer to take charge of road construction at a small per diem, when so employed, but even this change was regarded as too much of a sinecure in the direction of "fat salaried officers" and was amended so as to substitute the county surveyor. The experience with "pikes" in Pennsylvania is such that in Lancaster County, one of the richest in the State, the farmers' convention resolved to oppose the road bill on the ground that they were worse than earth roads. This is readily explained by the fact that these pikes were amongst the first built in this country prior to the railroad era; they were joint stock concerns and are still owned by parties who are unwilling to spend money on them for maintenance. In consequence, the foundation stones are uncovered by wear and wind so that in many places the road bed may be likened to that of a dry brook. It was the writer's misfortune to have to traverse about ten miles of one of these highways a few years ago at an expense of five hours of time and much patience, but there is no reason why with proper resurfacing at a slight cost they may not be made amongst the best in the State.

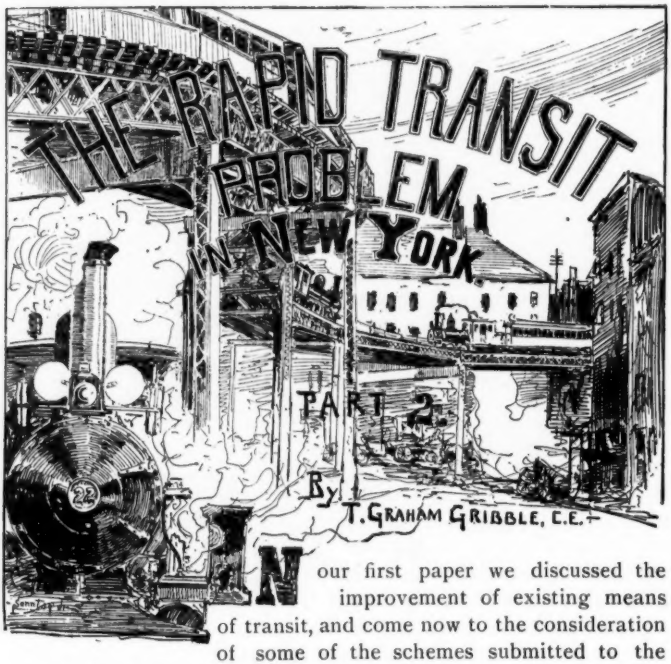
So general is the movement for better roads that it becomes difficult to specify the localities where improvements have already been started. Ohio, Indiana, Illinois, New Jersey, Connecticut, Massachusetts, Maine, New Hampshire and Vermont, Canada, California and Texas, and many other States and countries are joining in the refrain. In fact this may be regarded as the revival of the road era, and those States which first provide themselves with a system of good, firm highways, passable at all seasons of the year, will be the first to reach the goal of commercial, industrial and agricultural prosperity; while those which lag in the race will find themselves in the slough of despond.

To secure this end, the first step is a reformation of our political system whereby the works may be removed from politics and be placed under the care of men who have been specially trained for this kind of work; for it is certain that good roads cannot be obtained by electing men to serve with the expectation of making what they can out of the office. Some of the universities and technical schools are also devoting particular attention to this branch of engineering, and the popular, secular and technical press teem with valuable articles urging the importance of the movement. Prize essays are in order, and the latest and most original

competition in this direction is the offer by the New York and Connecticut Divisions of the League of American Wheelmen of three prizes, aggregating one hundred dollars, for the best collection of photographs showing the need of improved roads. It is hoped that this group of object lessons will tell the story so impressively as to pave the way for a speedy modification of existing legislative enactments. Entries to this competition will have closed on the date of issue of this number of THE ENGINEERING MAGAZINE, and soon thereafter results may be expected.

It is not within the purview of this article to enter the field of construction, as that falls within the province of the trained expert and would require a volume of special rules and principles. It will be sufficient to add that greatly improved results may be attained by any devices that will prevent earth and water from mixing on the road bed, and that much may be done in the way of improvement by a proper admixture of suitable earthy materials. The requirements of the material are that it shall not be readily affected by moisture, temperature or pressure, which are the three principal destructive agencies. Clay is very sensitive to water and temperature and has a high ratio of absorption. Sand has little coherence and yields readily to pressure. Gravel has great mobility, due to its spheroidal form, but by mixing these in the proportion of sixteen parts of clay, twenty-two of sand and sixty-two of gravel, an impervious roofing may be laid, which, if underdrained, will make an excellent earth road. In many sections the clay shales and slates make a good passable road. The "shell" roads of certain sections along the sea-board are celebrated for their good qualities. The Macadam and Telford roads when correctly made are excellent, but as built by most supervisors in this country they are pseudomorphs, unworthy their names.

When in the march of science the time comes for segregating the aluminum contained in the clay road into a hard, smooth, resisting medium covering its surface, we will then have a road metal, both in fact and name, which will solve the problem of the clay pit and give us a medium of transportation which will surpass even the railway in cheapness and convenience.



In our first paper we discussed the improvement of existing means of transit, and come now to the consideration of some of the schemes submitted to the commission for providing fresh and increased facilities.

To condense the desires of the public into one word, we might say that whatever special points of advantage a scheme may have, the great desideratum is *finality*, or if that cannot be realized, at least *permanence*. They want something that will "come to stay," like the urban railways of the great cities of Europe. The elevated railway has done great and good service, but it is an eyesore. Every year makes the public more restive under its presence. They would give much to be rid of it if they could get something better, not from caprice, but because citizens have some natural pride in the commercial capital of the New World and do not like to hear what Europeans say about it when comparing it with their own cities.

The appointment by the State Legislature of the present commission augurs well for the realization of the city's hopes. They are men of acknowledged ability and as far as possible non-partisan. They have devoted protracted study to the whole situation and are doubtless determined to discharge their task in a thorough and

comprehensive manner. Whatever is done, whether by private enterprise or by the city, to meet the present emergency, no temporary expedient will suffice. The city is developing so fast and has so noble a future before it that great and costly works must be undertaken without any loss of time, because *that future is dependent upon them.*

If the favored scheme be an elevated railway on a masonry viaduct, it should be constructed of a capacity double or treble that which is needed now. If it be a deep tunnel it should be of a dimension to accommodate the full sized railway car, and yet be constructed at a cost which would admit of extension in all directions under the city. If it be a subway system, it should for ever settle the underground pipe difficulty and solve the problem of good pavements and clean streets. It should also be capable of development throughout the city.

The want of finality about many of the public works of New York has been due in great measure to the rapidity of the city's upbuilding. No one could have foreseen the changes which have taken place, but the indications are clear enough now as to what may be expected in the future, and the science of municipal economy will have to be substituted for the practice of temporary makeshifts. The time has gone by for extravagances, and the city is in too large a way of business to trifle with its property and prospects. "Waste will bring want" in the city of New York as surely as in the cottager's home. Rapid transit construction is wanted upon a basis not of boodle but of business.

Enough has been said in our first article upon the magnitude of the problem of handling the traffic of New York, and something has also been said about its diversity and the impossibility of treating the whole subject under one head. Pursuing the division of the city's travel into external and internal transit, we will enumerate the principal desiderata in schemes which belong to either the one or the other class.

EXTERNAL TRANSIT OR CONNECTION BETWEEN THE ISLAND AND ADJACENT COUNTRY.

1. A comprehensive connection with existing trunk railroads.
2. Facilities for the transport of freight and baggage.
3. High speed (from forty to sixty miles per hour).
4. Comfortable travelling.
5. Appropriate architectural features.

6. A reasonable time of construction, not more than three years.

7. A cost which will admit of a fair interest upon the outlay.

INTERNAL TRANSIT OR FACILITIES WITHIN MANHATTAN ISLAND.

1. Accessibility, conspicuousness and constant service.

2. Adaptability to any of the lines of city travel.

3. The utmost possible rapidity of construction, say within twelve months.

4. Comfortable travelling.

5. Appropriate architectural features.

6. A speed of from twenty to twenty-five miles per hour including stoppages, *i. e.*, to traverse the length of the island in half an hour.

7. A cost which will admit of a fair interest upon the outlay.

The schemes which have been submitted to the commission are too numerous to describe fully, but the following is a partial statement of the principal ones.

Mr. Austin Corbin's deep tunnel scheme.

Messrs. J. Coleman Drayton and Col. Rowland Hazard's subway schemes.

Mr. Lucius Chittenden's high masonry viaduct.

Dr. Sheffield's elevated tunnel, a kind of compromise between the two last mentioned.

Mr. Thorp's four track or six track railway along the water front, to be constructed on land reclaimed from the river.

Mr. Louis Sterne's application of the Greathead system.

Mr. Frank Sprague's metallic tunnel system, resembling the above in principle.

Mr. Reno's four track subway railway tunnelled underneath the pipes and conduits of the city.

Mr. Gibson's combined surface and subway railway.

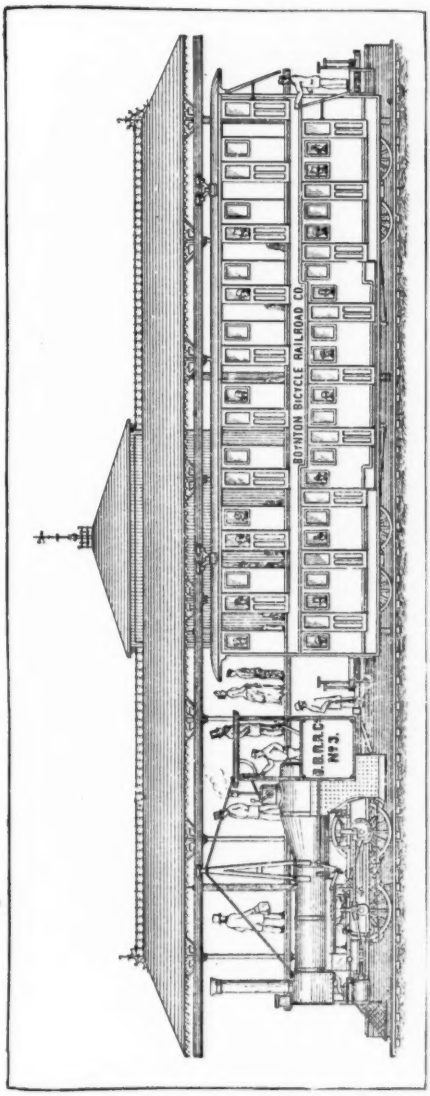
Mr. Forsberg's combined surface and subway railway, having ornamental ventilators in the street, including a conservatory.

The writer's combined surface and subway system.

Messrs. Wezmann & Bates three decker, six track elevated road on metallic viaduct.

Major Henning's gravity system on the "roller-coaster" principle.

Mr. Speer's endless train, or elevated railway with a loop at the end.



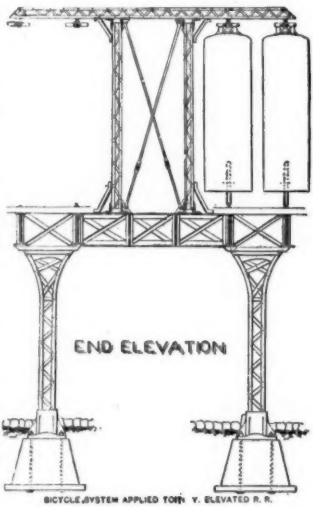
STATION ON BOYNTON'S BICYCLE RAILWAY.

The Boynton bicycle railway.

We will briefly allude to the last mentioned scheme first, because it was brought forward as a means of improving the Manhattan railway service upon which we dwelt at some length in our first article. The BOYNTON BICYCLE RAILWAY may be familiar to many of our readers from having travelled on the first railway constructed on that principle on Coney Island. Mr. Boynton with an inventor's enthusiasm undertakes to double the capacity of the elevated roads without altering the structure or track, but by running one of his trains on each of the rails.

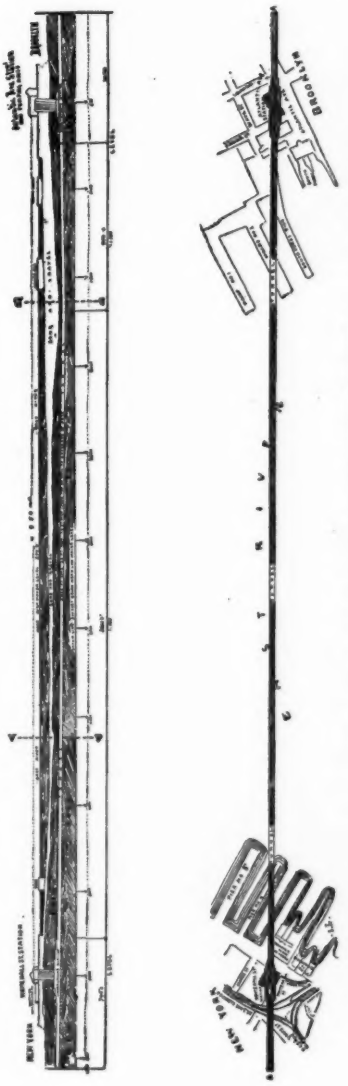
His principle is a sound one, and his application highly ingenious. The essential features of the invention will be evident from the illustrations without description. The

narrowness of his cars which is obligatory under his system would be always a drawback, but the principal difficulty he would have in applying his trains to the existing elevated railway would be in the structure itself. The bicycle locomotive weighs about twenty tons, so that when four trains happened to be passing one point simultaneously the structure would be subjected to a load of 80 tons, which it is entirely unsuited to bear.



BICYCLE SYSTEM APPLIED TO N. Y. ELEVATED R. R.

A scheme of a very different character and one which proposes an independent solution of the problem upon a grand scale, is the AUSTIN CORBIN DEEP TUNNEL SYSTEM. Mr. Corbin proposes to connect together Brooklyn, New York and Jersey City by a continuous straight tunnel, and also to make a belt line in tunnel following the east and west sides of the island and including the Annexed district. He confines himself for the present to the financing of the New York and Brooklyn Tunnel, reserving the rest of the scheme to the decision of the Rapid Transit Commissioners. The magnitude of such an undertaking is best imagined from the fact that it exceeds the Mont Cenis, St. Gothard and Simplon tunnels put together. The cost would probably exceed two million dollars per mile or sixty million dollars for the belt line. It would not cost anything for right of way, but neither would it have any real estate assets as compared with a viaduct scheme. Its chief merits consist in its non interference with pipe mains and sewers. It seems hardly probable that capital would be forthcoming for the whole undertaking at the present time, but it is possible that it may be ultimately the most approved method for exchanging trunk line traffic in transit. There is one feature of it which would be of great and immediate benefit, and that is the connection by tunnel of the Grand Central Station with South Ferry. People could then come in from Tarrytown to Wall Street in about three-quarters of an hour. It would also form a *three-way link* between all the trunk

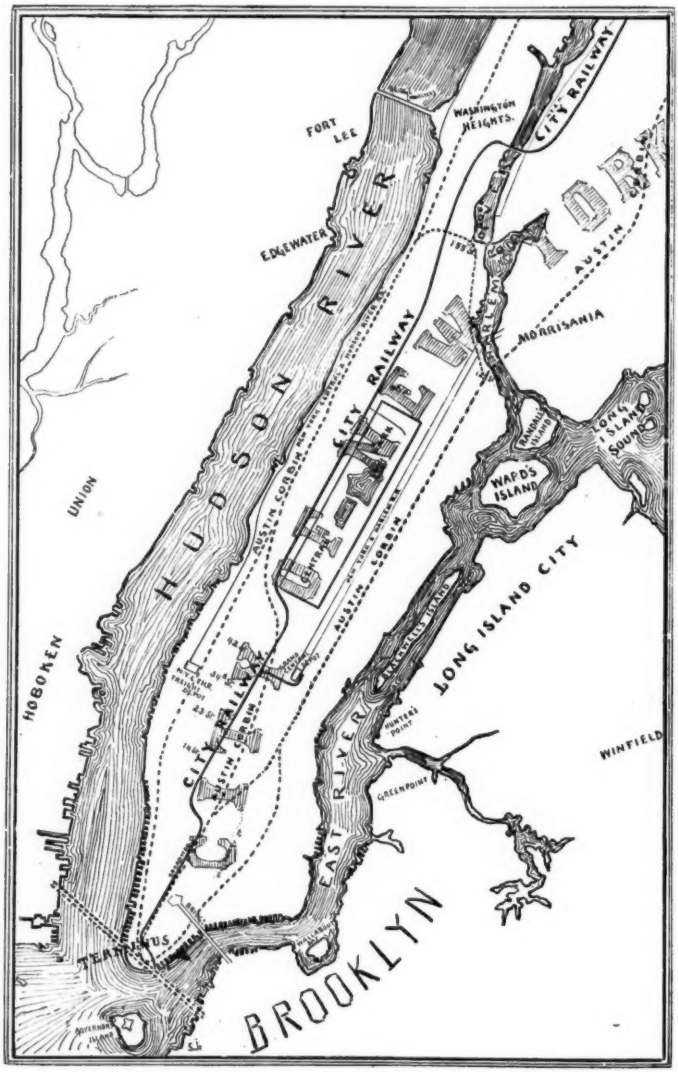


PROFILE AND PLAN OF AUSTIN CORBIN TUNNEL ACROSS EAST RIVER.

lines in New York, Long Island and New Jersey, both for passengers and freight.

Mr. Corbin proposes to use electricity as a motive power, but it is not quite clear from the state of the art that he will be able to handle such heavy traffic with economy by that means. He further proposes to undertake the short haul traffic by means of way stations. A system of this kind is not well adapted for the internal traffic of the city inasmuch as it lacks the essential feature of accessibility. The way stations do not *advertise* themselves, and passengers going a short distance would prefer to take a surface car, even if they would be a few minutes longer on the journey, to casting about in their minds as to where the way station is and then walking some distance and taking the elevator.

The scheme proposed by Mr. Lucius E. Chittenden for a viaduct through the city from end to end, may be termed a heroic measure. It is named the PEOPLE'S RAILWAY. The estimated cost is in the



ROUTES PROPOSED BY THE CITY RAILWAY AND THE AUSTIN CORBIN TUNNEL CO.

neighborhood of one hundred and ten millions, but it is argued that the rental from the buildings under the railway would, with the receipts from the traffic, yield a fair interest upon the outlay. There are several ideal features about the scheme. A straight line, a daylight route and easy gradients, all combining to render high speed possible with safety and comfort. Then a substantial structure would permit the running of heavy trains and the handling of a large volume of business. It is difficult to imagine that adjacent property owners would readily give their consent to a steam railway at their back windows if they could see another way to attain the object. The plan is, in a word, to purchase a new right of way entirely through the city and rebuild a structure suitable for residential purposes and storage and carrying a four track railway on its upper surface. It is argued that the experience from other viaduct railways in London and Berlin goes to show that adjacent property is improved by them, and is a desirable location for people to live in, the proof being that the advent of the railroad has raised the value of real estate. There is some truth in this argument, but in the main it is fallacious. Wherever a railway of any kind is carried into suburban districts, it raises the value of property; and there is a large body of citizens who like low rents and propinquity to a railway station, so they put up with the noise of the trains. The radiating lines from London are all illustrations of this fact. The Ringbahn of Berlin was built entirely in the suburbs, and the Stadtbahn* mainly so. But the conditions in this city are very different from those in London, Paris or Berlin. To carry a railway through a series of costly blocks such as now compose New York City would be quite another matter. It would be doubtful whether the leasing of property underneath the railroad would be a much greater success under this viaduct than under others.

There have been numerous projects for an underground railway, and the scheme known as the CITY RAILWAY is one of the latest developments of a series of schemes, known as: The ARCADE RAILWAY; DISTRICT RAILWAY, and the UNDERGROUND RAILWAY. Promoted by different financiers, they have one common feature: the traversing of the city wholly or in part by means of one of its avenues directly under its surface. The motive power proposed is

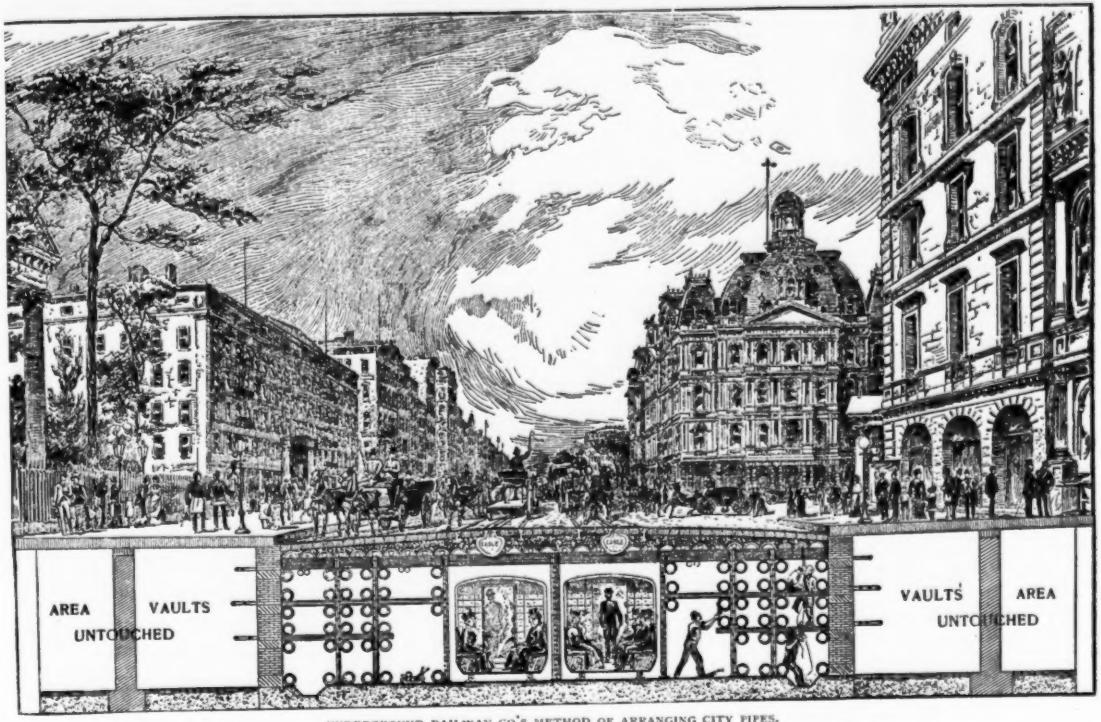
* The actual cost of the 4-track Stadtbahn, 7½ miles long, was for right of way about 8½ millions and for works about 9½ millions. Total, $18,000,000. The estimated cost of the 4-track New York viaduct, about 12 miles long, is for right of way and works each 53 millions, or together $106,000,000.

electricity. The City Railway is designed to traverse some of the down-town sections of the city by cutting through the blocks and joining Broadway where it widens, thence following it and the Boulevard to Washington Heights, and crossing the Harlem River by a handsome bridge. There is much more reason for expecting a return upon real estate purchased for right of way, when the buildings are over the railway than under it. The first cost would also be less than the viaduct scheme, by the amount of line which was laid under the existing avenues. There is on the other hand with every underground scheme just under the surface a difficulty with electric cables, and gas, steam and water pipes in most phenomenal confusion. The underground railway necessarily makes it a feature of the scheme to dispose of these pipes in a manner which will render them accessible without disturbing the pavement in future,

METHOD OF EXCAVATING BENEATH STEEL FLOOR—GRIBBLE.

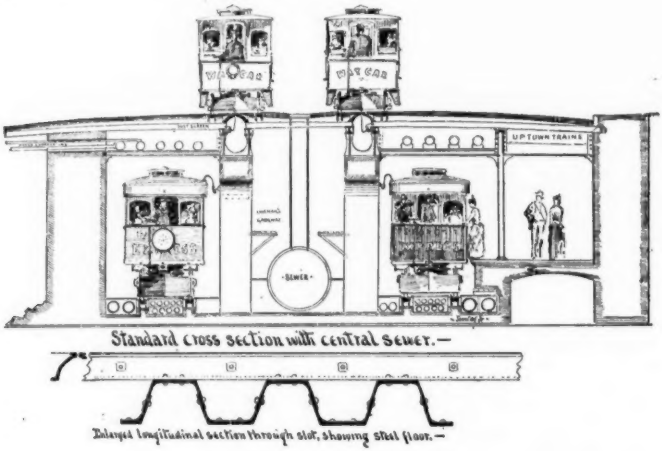
and is consequently in a position to expect a set-off in rent from pipe owners against the first cost of the diversions. The estimate of cost of the City Railway, with four tracks partway and two tracks the rest, is about fifty-seven million dollars.

The GREATHEAD SYSTEM, energetically represented by the New York agent, Mr. Sterne, has had a considerable advantage of position inasmuch as it has been tried in London, and Mr. Sterne has been able to lay very frequently before the commissioner three interesting facts. First, that he is constructing the Hudson River Tunnel at the rate of ten feet a day by means of the Greathead shield; secondly, that the London and Southwark subway has been in operation successfully for some months, constructed entirely on this system; thirdly, that the construction of another line has been sanctioned by the government in London upon that



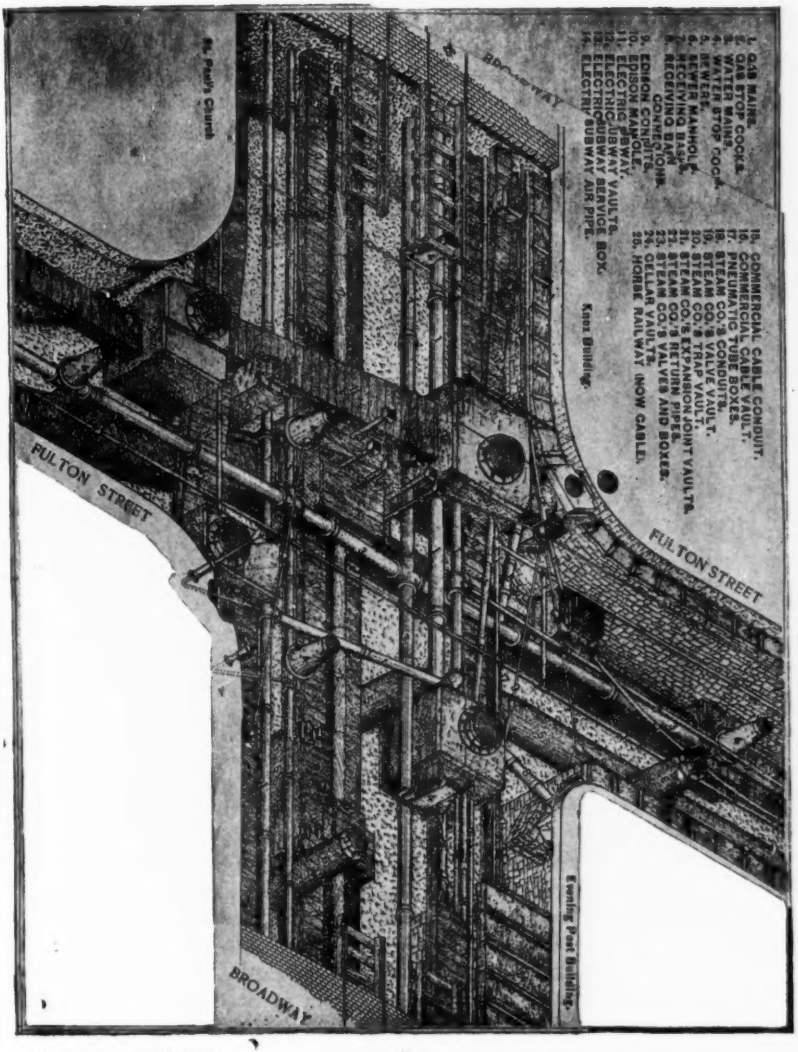
UNDERGROUND RAILWAY CO'S METHOD OF ARRANGING CITY PIPES.

system, and Sir Benjamin Baker is sponsor for it. There is rather a weakness in some people's minds in this city for anything that has been done in London, (excepting always the Metropolitan railway) and the London subway, operated by electricity, has proved so fascinating an idea, that one of the leading newspapers has forestalled the decision of the commissioners by prophesying the adoption of the system. We have already touched upon the Austin-Corbin tunnel and its strong feature of traversing any part of the city without interfering with real estate or pipe-lines. The Greathead shield has this further point in its favor, that it can come nearer to the surface and traverse waterbearing strata; consequently the elevators would be shorter.


UP TOWN TRAINS
SEWER
Standard cross section with central sewer.—
Enlarged longitudinal section through slot, showing steel floor.—

THE GRIBBLE COMBINATION SYSTEM.

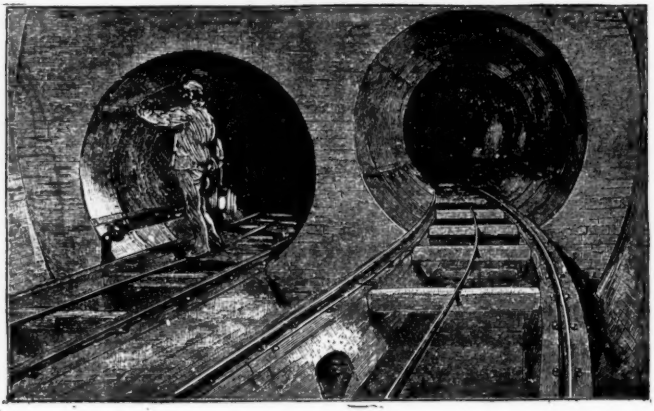
It is now successfully traversing the silt bottom of the Hudson River, and in any underground construction which involves crossing either the estuaries or the Harlem River would be found very helpful. The Greathead system as it is now called is not by any means a novelty. It is an iron cylinder which is built up in segments by means of an annular cutting machine, protruded by screw-jacks or hydraulic-jacks. This cutting machine is in the form of a disk, termed a shield, having a trap-door through which the miners pass to and fro to excavate a space ahead of the shield, into which they force it by the jacks. About half a century ago the celebrated Brunel built the first Thames tunnel by means of a very costly



ISOMETRIC VIEW OF PIPES AND SUBWAYS UNDER BROADWAY AT FULTON STREET.

shield in rectangular segments, and about a quarter of a century ago Mr. Barlow and Mr. Vignoles (?) built the second Thames tunnel with a shield almost the same as Mr. Greathead used on the London and Southwark subway. Mr. Greathead has invented an ingenious and very important improvement in the "grout injector." He forces a grute cement concrete or mortar through holes left in the iron tube, so as to completely fill the space between the excavation and the tube. Thus he: 1. distributes the pressure equally; 2. makes the tube water-tight, and 3. preserves the iron.

It is quite possible that this system will be largely adopted in London, where the city rests on a deep basin of stiff blue clay. New York on the other hand is mostly on a rock formation, in



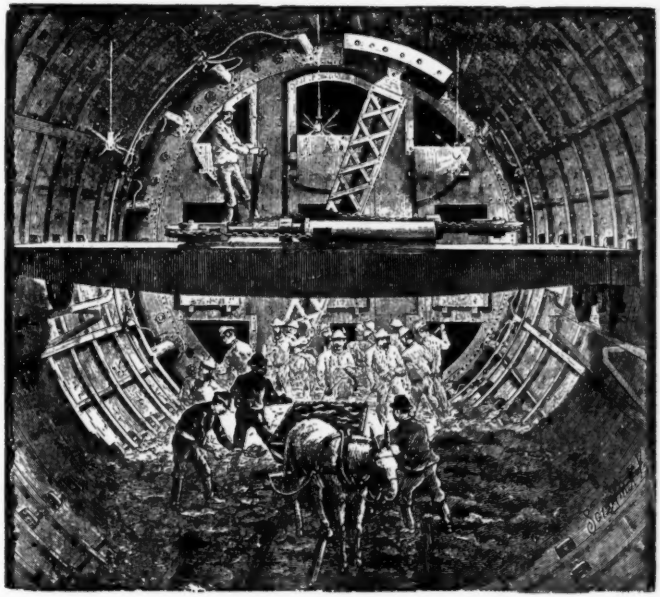
CROSS SECTION OF LONDON SUBWAY—GREATHEAD'S CONSTRUCTION.

which no such expedient would be needed. Rock-tunnelling is quite expensive enough by itself without lining it with steel. Mr. Sterne estimates the cost of a single track tunnel at about one million dollars per mile.

GIBSON'S, RENO'S, FORSBERG'S AND THE WRITER'S SYSTEMS, are all proposals for a combined surface and subway railway. Mr. Gibson's and the writer's were simultaneously presented at one of the first of the sessions, the others later.

The advantages of such a combination hardly require demonstration. The surface car, operated mechanically, is the most accessible conveyance possible. It *advertises* itself, and handles distances of a mile better than any other conveyance. When

worked in conjunction with a subway line by means of transfers, it would feed the latter and enable it to be operated with stations a mile apart. This would greatly simplify the problem of rapid ransit, which is hampered on the elevated road by the vain attempt to have frequent stations and yet make good time. Passengers would not require to walk to the stations; they would hail the first surface car, and on arriving at the station would only have a few steps to descend.



TUNNEL CONSTRUCTION BY MEANS OF GREATHEAD'S SHIELD.

It is claimed for the writer's method of construction that :

1st. A four-track road, with 2 surface and 2 subway lines, can be built at a cost which will pay 5 per cent. on the outlay, including present capitalization of surface road.

2d. It can be built in from 8 to 12 months.

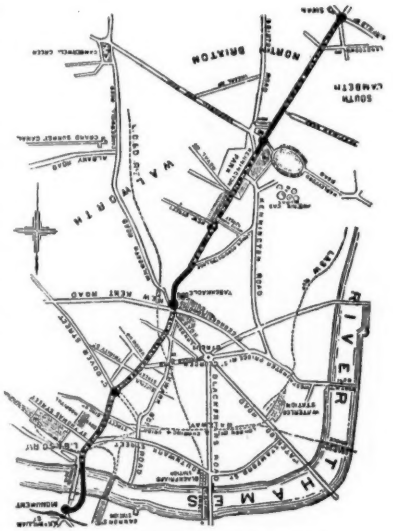
3d. It can be built without disturbing the pipes to any serious extent.

4th. It can be built without interrupting the traffic of the streets.

5th. It will leave the surface of the street permanent, that is to

say, never needing to be disturbed in order to obtain access either to the track or the pipe lines.

The method is, briefly, a simplification of the subway construction in Cannon Street, London, carried out by Sir John Hawkshaw on the Inner Circle Completion contract of the Metropolitan Railway. There a temporary roof-floor of timber was laid down in place of the pavement; it was then mined and underpinned, the side-walls built up and a permanent iron roof-floor substituted and paved.



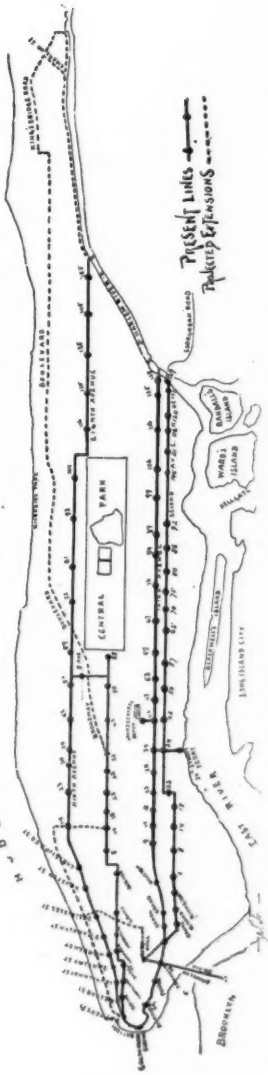
MAP OF THE LONDON SUBWAY CO.'S ROUTE.

Both the temporary and permanent roof-floors were laid by night, between midnight and 8 o'clock in the morning.

When constructing a combined surface and subway system, it would be simpler, more speedy, and also much less costly, to lay down the permanent roof-floor by means of a kind of corrugated iron in halves, which would have sufficient bearing surface upon the soil to prevent settlement during the driving of the headings. When the iron roof was underpinned the earth would be cleared away round the pipes, which would be temporarily suspended from the roof by traversing rods furnished with turnbuckles. In this way the pipes could be either left in place or else very gradually diverted vertically or laterally. Such pipes as were to remain in position would be finally left on iron transoms built into the side-walls and forming a gallery above the railway accessible at all times to linemen. Some very large sewers and other pipes are carried in this manner or on girders across the underground railway of London.

This roof-floor of corrugated iron, or trough girders as they may be called, requires no riveting. It could be laid down at night when there is very little traffic on the streets, and simultaneously right

JAY GOULD'S PLAN FOR RAPID TRANSIT.



through an avenue. The subway construction would then be carried on without the public being aware of it, and it would be also attacked right along the line. Every block would have four adits at the corners of the cross streets, and could be let to a separate subcontractor who would furnish his own labor, and thus solve the problem of handling a vast body of men simultaneously and without getting in one another's way.

It is claimed by the advocates of elevated railway extension that the cost of underground railway construction would be such that no five cent fare would pay, and an increase of fare is of course out of the question. The substance of that argument is in the difficulty with pipe lines, and if it were sound it would go very hard with the present cable construction. A subway such as has just been described treats the pipes in a much less drastic manner and provides facilities which the cable construction does not. Beyond the pipe question, the estimates of cost of underground railway construction are not in any way conjectural. Allowing two million dollars for all possible contingencies with pipe diversions, it can be easily shown that a four track combined surface

and subway road can be constructed for a sum which will yield 5 per cent. upon revenue from present travel without allowing for development.

In conclusion, the writer's views as to the best present solution of the problem are as follows:

1. *For external facilities.*—The construction of a tunnel of very large capacity from Brooklyn to New York, somewhere in the vicinity of South Ferry and thence to Grand Central Station; also the prolongation of the present Hudson River tunnel to meet said tunnel, or else another Hudson tunnel making the shortest cut from South Ferry to the New Jersey shore.

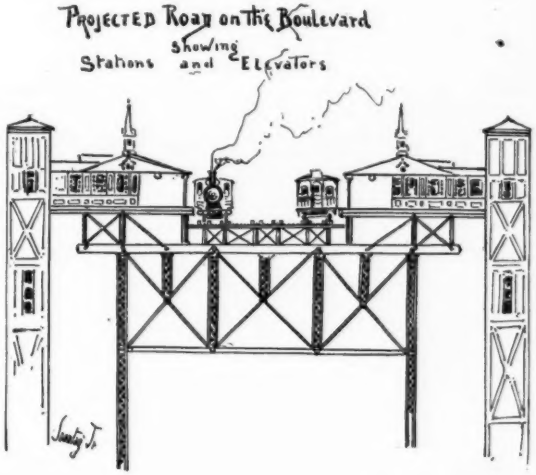
2. *For internal facilities.*—A combination surface and subway system as just described, on three avenues: Broadway as one, and the other two as far as possible to the east and west; operated mechanically, the surface road as fast as consistent with safety, and the subway road at from twenty to twenty-five miles per hour.

Since writing the foregoing, the Manhattan Railway Company have submitted their amended plans, as shown in the accompanying map. The only part of the scheme which makes any pretensions of being a solution of the problem, is the three track line through Broadway and the Boulevard. The question of sacrificing this fine promenade for such a purpose we have no space to consider, and must confine ourselves to the two practical questions: as to whether the scheme would be likely to furnish the required speed, or to insure the necessary safety. In the first place, the present speed on the down-town sections of the Ninth and Sixth Avenue roads cannot be increased. It must therefore throttle any new traffic which might be brought to it, and prevent it from giving rapid access to the southern parts of the city. In the second place, the inadequacy of the present structures to receive fresh loads, and the impossibility of strengthening them, invests the scheme with very decided danger. The conclusions arrived at in our first article have received a significant commentary in the reported interview of the representative of a leading newspaper with Mr. Gallaway, vice-president of the company, who is stated to have said that the new structure would be of flat girders solid riveted throughout. "Flat" is probably a misprint for "plate." He says that "the present lattice girders act under vibration like scissors and gradually sever the bolts which hold them together so that they constantly need care and attention." It is not the type which is at fault, as Mr. Gallaway would have us infer. Lattice

girders can be built to carry any load without the least "scissor" action taking place. There is only one meaning to the words of the vice-president and that is that the *structure is overloaded and the rivets are being sheared.* This is however not the only destructive action at work. It is one of the outward and visible signs of an inward and radical deterioration. Hidden dangers probably exist upon the elevated railway of which the public are utterly unconscious. A loose rivet can be easily detected but a crystallized bar only betrays its loss of vitality by breaking.

The driving wheels themselves carry double the loads for which the structure was built; but in addition, in places where the frogs are deeply furrowed the driving wheel strikes them a blow which must at least double the effect of the load upon the girder itself. The statement of Mr. Gallaway is one which should stimulate an inquiry into the strength of the present structure independently of any fresh undertaking.

The idea of building a solid construction for the new up-town feeders of the Manhattan system and so to bring heavier traffic upon the weak down-town structures resembles a proposal to armor-plate an old cruiser with rusted bottom-plates and leaking rivet-holes. It might impress the imagination of a land-lubber but a seaman would look upon it as a rapid transit facility into "Davy Jones' Locker."



THE IRON MARKET AS A BAROMETER OF TRADE.

By E. J. Shriver.

THE present position of the iron trade is one of very grave importance, not only to those regularly engaged in it or dependent upon some of its products for use in their own business, but we may fairly say to all branches of commerce; so generally is the relative prosperity of this particular department recognized as being an index to the probabilities of improvement or decline in all. Leaving for a moment the consideration of what has given it this accepted character of a commercial barometer, let us briefly glance at the conditions which it presents to-day, and which have so greatly puzzled those most used to following its fluctuations.

It would seem to be a rule of commercial life rising to the dignity of an axiom, that prosperity in any given branch of industry could be gauged, if not by a relatively high range of value for its product, at least by such liberality of demand as would stimulate a large output; and in past years iron has formed no exception to this rule. But in very recent years a most curious anomaly has been presented. From an annual product in this country that had grown gradually though rapidly, from about 2 million tons as a rough average between 1870 and 1880, to about $4\frac{1}{4}$ millions for the next five years, there was a sudden bound to 6 millions in 1886, $6\frac{1}{2}$ millions in 1887 and 1888, $7\frac{1}{2}$ in 1889 and $9\frac{1}{4}$ in 1890. Such a growth was unprecedented in the history of iron production the world over; but even more singular were the trade conditions that accompanied it. The year which witnessed the first step in this marvellous expansion, 1886, was a "fat" one, as were 1887 and to a less extent 1888, when slower progress was made; but 1889 and 1890, boasting the most sensational figures of all, had all the characteristics of extreme depression. Not only did prices remain almost stationary, though with a slow downward tendency, but trade all through seemed to be excessively dull and demand excessively slack, despite the fact amply proven by the paucity of surplus stocks, that all this enormous product was being absorbed by consumption. To the most careful observer the market presented

precisely the same features while iron was being made and used at the rate of 9¼ million tons a year, as it has since the production has been cut down—during the early months of 1891—to a basis of 5½ millions, at which it still seems to just balance the requirements for metal.

We have always been too apt to look to railroad building as the chief source of demand for iron, and these most recent developments plainly show that under present conditions at least (since the rail output was not only a smaller percentage of the whole, but even showed an actual falling off in quantity during these years that pig output has grown fastest) we must lay the fluctuations in demand for the metal at some other door. From consuming one-half to two-thirds all the iron product in rails alone, the use for this purpose has sunk to hardly one-fifth of the whole; and two-thirds even of this proportion has gone, not into new track, but into renewals, which are subject to comparatively little fluctuation from year to year. So manifold are the uses of iron that it is impossible to analyze them all; but the following table will show the percentage absorbed by each of the larger groups into which it is possible to classify the entire consumption:

	1881.	1885.	1887.	1890.
Rails of all kinds	35½%	21 %	32%	20½%
Rolled iron, excluding rails and nails	30½%	31½%	29%	23 %
Nails	4½%	6½%	5%	4 %
Miscellaneous forms of steel	12 %	16 %	21%	27 %
Consumption unclassified	17½%	25 %	13%	25½%
	100	100	100	100

Looking at these figures, we begin to get a glimpse of why it is that iron has come to be looked upon as indicating with unfailing accuracy the state of trade in general. Under the head of "rolled iron" is included for the most part the heavier shapes in which the metal is so largely utilized, as beams and plates; but this is a division which also bears its relation to every blacksmith shop in the land. It is here, too, that we may observe with most distinctness the change from iron to steel for the same class of uses; the "rolled iron" and "miscellaneous steel," taken together, gradually advancing from 42 per cent. of the whole in 1881 to 50 per cent. in 1890; but the relation as between the two being nearly reversed in the ten years. But the unclassified consumption, which means chiefly consumption in the myriad foundries of the country, is that through which the iron trade is most closely bound up with all

forms of industrial life, and it is this consumption whose almost imperceptible swelling and shrinking has most influence on the varying prosperity of the trade.

When we see great buildings going up, each with its hundreds of tons of iron in columns and floor beams, its thousands of pounds in nails and screws, in door and window fastenings, and weights and hinges, its sheet-iron roof and pipes, and cast-iron grates and furnaces, it is not so hard to realize that the activity of our iron works must bear a tolerably close relation to the briskness of building operations. But it does not so often come directly home to us how large is the individual use by every citizen of iron in small forms; how quickly a good harvest is reflected in an increased consumption of tools, not only by the farmer but also by the produce merchant who handles the larger crop, or perhaps even by the option broker whose commission account on purely speculative orders gets its contribution from the fuller current that is swelling the channels of trade, and who feels warranted thereby to indulge in a little larger expense in improving his suburban plot of land. Of such apparently infinitesimal items is one-fourth the consumption of iron chiefly made up; and it is because the tentacles of the industry are thus spread out into every home as well as every workshop, because so large a part of the year's product of pig goes into tools or carriages or cutlery for ourselves, into stoves and kitchen utensils for our wives or toys for our children, that iron has come to be taken as a commercial barometer. All of these things we save on when times are bad and buy freely when times are good; and it is because of this, as well as because another large percentage is used up in structural shapes, the demand for which also depends entirely on the general state of trade, that the consumption of this one trade responds more quickly than that of any other to the pulse of industry, which usually gets its first impetus in the wheat fields of the nation and grows slacker when these are scant.

The building of a few thousand miles, more or less, of new railway track, calls for a quantity of the metal that looks large because it is more clearly seen; the total quantity used for rails is undoubtedly very large. But of this, the larger part is for renewals of old track, which is a comparatively constant quantity; and the fluctuation in demand for this one use, as between the largest and smallest years of recent date, is less than 1,500,000 tons; while the total consumption has varied in less than a decade as much as 5,000,000 tons.

The governing causes are the same for all, of course; but it is with what we may call the household use of the metal that they have the most intimate relation.

What, then, has caused the phenomenal expansion since 1885? and why is it that this has been coincident with an abnormally low range of values and such persistent stagnation in the trade? To some extent the two parts of our question answer each other; the direct inducement to the great consumption which we have seen being undoubtedly the low prices which have prevailed, and these again are as certainly due to the vast supply which has been called into being by the conditions of the past few years.

It is these conditions which show most change from those of the earlier period; a change which is great enough to warrant the belief that we must readjust all our standards of comparison for the future. And it will be hardly a matter for surprise that an inquiry into the causes which have been making the change will lead up to the ubiquitous tariff question. The old rule for determining the price of nearly all forms of iron is a rule no longer. While it was still in force, domestic values (except for a few special articles, such as steel rails, on which the Bessemer patents came into play) constantly tended to settle to a point that was just under whatever might be the foreign price, with the freight to this country and duty on pig iron added. The rate on pig iron only was a factor, because makers of other forms could easily import foreign pig if domestic pig was raised above the cost of importation, while makers of pig could not well import foreign ores in large quantities, because with the metallic percentage in the latter had to be transported so much waste mineral that the freight charge on this became prohibitory. As a natural consequence, ore producers, so long as sources of ore were limited in proportion to the number of establishments where ore was consumed, were enabled to demand such prices for their ores as would just leave furnace men a margin to undersell foreign pig.

Prior to the new era of iron making precisely this situation prevailed. Furnaces and mills had been gradually multiplied in Pennsylvania and Ohio, the principal centres of the industry, until their regular demand for ore was slightly in excess of the quantity which the comparatively few mines within access were under any stress to put upon the market annually. But with the settlement of political affairs in the South that followed the Hayes administration, came a diversion of capital to that section from the somewhat

overworked railway field of the West. Vast mountains of coal and iron ore were thrown open to use, practically for the first time; not at lower actual cost than those of the East, but in greater available quantity. Alabama now presented conditions precisely the reverse of those in Pennsylvania.

There the demand for ore from established works was in excess of the supply being offered. Here it was the mines who had to seek customers. Ore cannot be shipped long distances unless it is of very high metallic percentage, as is that which comes from Lake Superior to Pittsburgh; but must be smelted near at home. Until enough furnaces were built in the South, therefore, ore producers there had to concede to the few furnaces which could afford them a demand, prices which enabled the latter to make pig at a cost that bore no relation to the tariff-governed values of the East. Mine owners who were also furnace men had to compete on equal terms to keep their furnaces running, which under these circumstances constituted their more productive property.

Following out the natural law of compensation, the tendency was now to supplement the comparative deficiency of furnaces; for with the broader consumption which had been created by the low prices resulting from this new and keener competition, there was a market for all comers. It was a matter of months now, or weeks even, rather than of years, before a plant was in existence whose capacity so far dwarfed what we had been accustomed to as to make that seem absurdly small. So rapid was the progress in this direction that Alabama probably stands to-day where Pennsylvania did ten years ago, in respect to the relative equilibrium of ore banks and furnace stacks.

But the furnace stacks cannot be let lie idle as could the ore banks; they must be worked or they will decay. Nor can their possible product be sold for any such prices as could the product of the old and smaller capacity. We have gone at one bound, from a state of output restricted by relatively high prices, to one of prices low enough to permit of consumption absorbing the much greater quantity now marketable. The first quarter of 1891 saw production cut off to something like the old figures, but it is impossible to assume that this condition can long continue, or that the works will be permanently left with their blasts cold and their machinery rusting.

It is the unreadiness of the trade to adapt itself to the new conditions that has made business move so haltingly even while an

unprecedented volume of metal was being made and taken off into consumption. Men could not easily convince themselves that the normal average of pig was no longer to be $25 a ton or even $20, as it had been it the past; that a steady market of $16 @ $18 did not mean such disaster as had coincided with these quotations in years gone before; in face of which it behooved them to move cautiously. The scale of the barometer had been altered over night, as it were, and in the morning we hardly knew how to read it.

But that this truly precious metal will return to its old pre-eminence is not to be doubted. Its uses are as numerous and as essential as ever: its share in our daily economy is as great. The readjustment of price may even yet not be complete, and so, if we take it as the fingerpost on the commercial highway, it may as yet lack the figures that will tell us the miles to improvement or decline; but the tonnage for which there is a demand will still point us, as it increases or declines, in the true direction. Taken by that standard, our barometer indicates "fairer weather" for a few years past than other signs would seem to confirm, and thus gives a clue to the lines on which we must correct our reading;—that 9 million tons consumption at the new value does not denote as great prosperity as two-thirds the quantity might at the old. As we look at it now, it seems to have turned rather ominously to "storm," in that we have fallen off so suddenly in our apparent ability to buy: but here again we must wait a little longer to get our true bearings before we can be certain that it is not the traders in the market whose judgment is really astray in such unaccustomed surroundings.

ELECTRICITY IN MINING OPERATIONS.

By H. C. Spaulding, S. B., M. A. I. M. E.

THE use of an intangible and invisible agent in the solution of any engineering problem naturally excites the interest of the public at large, as well as those more intimately connected with scientific work, while the wonderful developments of electrical research during the last decade challenge the admiration of all, especially if viewed from an economic standpoint.

Electric illumination has passed from the laboratory-experimental stage to that of a vast and unique industry, offering occupation alike to the day-laborer and the skilled inventor throughout the civilized world, while at the same time the criminal records of our centres of population show most conclusively its protective influence. Engineering enterprises of every conceivable variety have been hastened to completion by its means, with a direct monetary saving as well as increased safety to life and limb; while the absence of air-vitiation in places of public resort is certainly not the least of the benefits for which humanity is indebted to this subtle force.

In its application to power transmission for commercial purposes, whether we consider the electric motor while cooling the air of a sick room, displacing the pitifully overworked horses on our crowded city streets, or running sewing machines for the pale and emaciated women in our tenement house districts, the philanthropist may (as has not always been the case in other lines of so-called scientific advance) lend hearty support to the employer and engineer.

We cannot expect the adoption of any invention or improvement solely for reasons of sentiment, but we can at least give due consideration to the humanitarian aspect of a line of work which as far as financial results are concerned will tell its own story. A gentleman thoroughly conversant from personal experience with the operation of tramways by animal and electrical power, recently remarked to the writer: "If I did not save a cent in operating expenses, I would change to electrical power if it were merely to save dumb animals from the ignorant and wilful abuse to which they are constantly subjected." When we consider that in this instance a saving of from 25 to 30% in operating expense had been effected, we need not wonder that electrical traction is to-day a fact rather than an experiment.

The adoption of railway and stationary motors has indeed been so rapid during the last four or five years as to tax to the utmost the inventive and constructive resources of the whole country. The constantly increasing variety of special applications together with the practical advisability of making electrical apparatus an integral part of the machinery to which it imparts energy, renders it almost impossible to standardize to such an extent as with apparatus less thoroughly incorporated with the driven machinery; and demands in consequence an amount of time and expenditure of engineering resources often apparently out of proportion to the results obtained. It is accordingly not a matter of surprise that the field opened to

ELECTRIC POWER STATION AT ASPEN, COLO.

Mining Engineers by the possibilities of electric power transmission has not been entered with the same zeal as would be expected, were the problems presented less complex and the results of possible failure less disastrous. The natural conservatism of the mining fraternity, with a wholesome realization of the failures already made in above-ground experiments, will however render the gradual introduction of electrical apparatus into mining operations comparatively free from the pernicious effects of incompetence, whether ignorant or malicious.

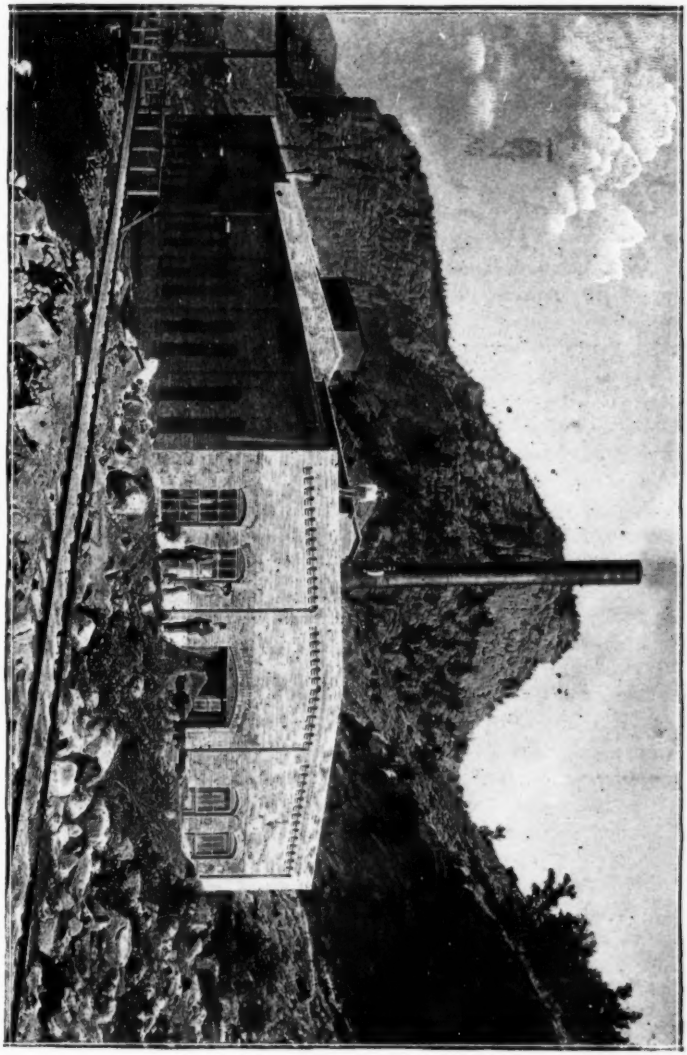
It is the purpose of this article to outline briefly the mining processes to which electrical apparatus has been applied, limiting

our consideration to the cases in which the complete cycle of action takes place, *i. e.*, the conversion of mechanical into electrical energy and back again into mechanical, thus omitting not only the chemical and metallurgical processes, but also those involving the use of minor currents, such as signalling, firing blasts, etc., etc.

Naturally, and advisedly as well, the earlier steps in electric mining work involve simply the application of electric motors to the steam and compressed air apparatus already in operation, and in fact the entire system of electric power transmission presents many close analogies to the principles governing the use of compressed air. Instead of the compressor, we must use a dynamo or "generator" for transforming our primary energy into a more convenient form; and the air pipes on the one hand and metallic "conductors" on the other, must have a capacity corresponding to the amount of current flowing through them, while the pressure or "voltage" of the transmitting medium governs in a great measure the distance at which the requisite amount of power may be delivered and the amount of loss attendant upon such delivery. To complete the simile, however, the air system should be provided with return pipes from the pumps, drills, or what not, back to the compressor; as our electric current, obedient though it may be in most ways, absolutely demands that a complete path or "circuit" be provided for its passage, and unless this be offered artificially, or by the necessary earth contacts, will absolutely refuse to assist us in any way. Though the method suggested above (a "ground return") is always theoretically possible, and oftentimes advisable with minor currents, it is generally found better in practice to provide a double metallic connection between the generator and the motors to which current is supplied.

As compared with the use of compressed air, the advantage is shown in the superior efficiency of the generator as compared with a compressor; ease in running the line to the point of operation; freedom from leakages due to corrosion and mechanical injuries; flexibility and time saved in alterations and repairs; absence of the "freezing" tendency of air machines working at high pressures; and last, but most important of all, the comparatively low ratio of increase in friction losses or "drop" for a given increase in transmitting distances. On the other side, we must consider the increased first cost of plant, and possibility of *fire under exceptional

* This objection should be entirely negligible except in coal mines charged with inflammable gases.



THE POWER HOUSE—PLEASANT VALLEY COAL COMPANY, CASTLE GATE, UTAH.

circumstances, danger of personal injury being impossible with the voltage adopted by the best engineers for mine work. In the use of direct steam, we gain slightly in the absence of a compressor or other energy-transformer, while for any but short distances the losses from radiation and leakage are excessive, danger to employés is increased, and an exhaust pipe must be provided for carrying away the expanded steam to some desirable spot, or condensing it if used for pumping work. The possibility of operating drills, pumps, hoists, locomotives and lights from the same system of wires, is again a matter of considerable economy in some classes of work.

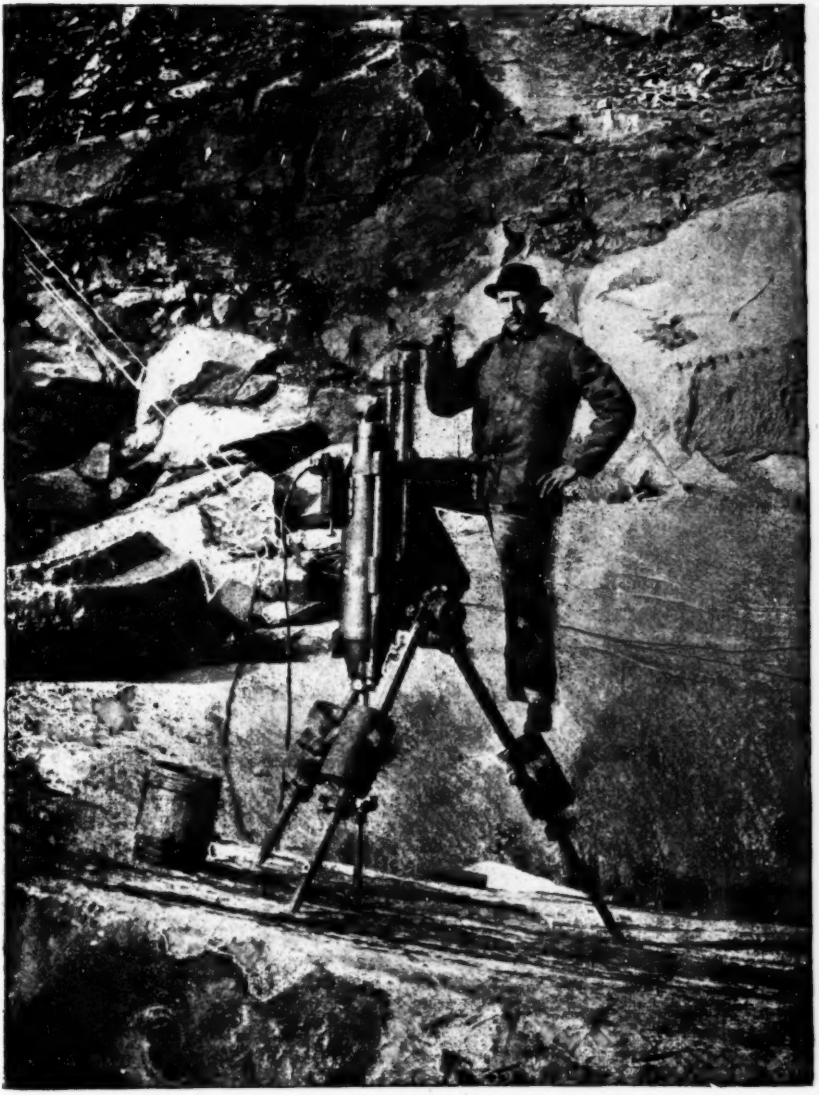
The above considerations, though of sufficient weight to warrant the careful consideration of mine operators under any circumstances, appeal still more forcibly if nature has provided water power within available distance of the mine location.*

A number of mining properties in the United States and Mexico are to-day being reopened on a paying basis, using adjacent water powers with electric transmission, which a few years ago were abandoned on account of the high cost of fuel. In other cases, although the latter item is not prohibitive, the saving in running expense is sufficient to more than warrant the investment necessary to provide an electrical equipment; while in our Western States a number of "power companies" have been formed, supplying the necessary current to the mining organizations at a fixed rental, precisely as a water or gas company supplies its patrons.

Such a power station has been installed at Aspen, Col., containing eight Pelton water-wheels, working under a hydraulic pressure of 380 pounds per square inch, and developing 150 horse power each at a speed of 1100 revolutions per minute. These are connected with a number of dynamos, which in addition to furnishing arc and incandescent lights, operate motors for hoisting, pumping and quartz-crushing more than two miles away.

A steam and electrical power house recently erected by the Pleasant Valley Coal Co., at Castle Gate, Utah, is a substantial brick building containing a complete steam and electrical plant of 750 horse power capacity, furnishing all the necessary power for

* This distance of course varies with the cost of coal or other fuel, but roughly stated, in most parts of the United States the total running expense of transmitting large amounts of power from water privileges by electrical means, will equal the local consumption of fuel necessary for generating the same amount, by the most improved methods, if the distance be more than fifteen or twenty miles; though much depends upon the size of the units in which the power is to be delivered.



ELECTRIC RECIPROCATING DRILL, FOR QUARRYING AND TUNNELING.

running hoists, ventilating fans, drills, etc., etc., in the mine adjoining.

The accompanying scheme will indicate roughly to what an extent electrical apparatus may already be applied to mining processes, while new types and modifications of the older forms are continually coming to the front.

Primary Power	Excavating	Drilling.
		Channelling.
		Undercutting.
		Firing Blasts.
	Transportation	Sub-surface haulage.
		Hoisting.
		Surface transportation.
	Treating	Crushing.
		Separating.
		Clearing.
		Metallurgical processes.
	Contingent Operations	Ventilation.
		Pumping
		Lighting.
		Signalling.

All the operations shown in the right-hand column of this scheme, though differing widely from each other, may not only take place simultaneously and independently of each other, but may utilize the current flowing through a *single system* of wires, generated, it may be, by a single dynamo-electric machine.

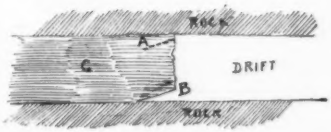
Following roughly the order of processes indicated, we have under the general head of "drilling" apparatus, the "prospecting" or "core" drill, the ordinary rotary drill, suitable for hard coal mining, and the reciprocating or "percussion" drill, for general rock work and used ordinarily for making the holes in which the blasting cartridges are placed. In a new form of this apparatus two or more conducting coils are placed one above the other in an iron tube, having the general appearance of the cylinder of an air or steam drill. Inside these coils, and free to move longitudinally through them, is an iron core which acts as the drill shaft. A current is automatically passed through one coil after another, and the tendency of the core to assume a position such that its centre shall coincide with that of the coil energized, gives it a motion almost exactly similar to that of the piston of an air or steam drill, but with a magnetic cushion at the end of each stroke which precludes the possibility of injury in case of too slow a feed.

By the use of "undercutting" machines the cost of mining soft coal can be materially reduced, the "undercut" requiring only about one-quarter the time which has hitherto been necessary in

hand work, and with a further saving in the amount of waste or "slack." The dotted line A in the diagram shows the direction of the blast holes in the vein of coal C, shown in vertical section, while B shows the method of cutting under the face of coal in order that the blast may take effect and "blow down" properly.

In an electrical device for accomplishing this, a wrought iron frame carries a series of drills, revolved by a motor, which is fed forward with them as the cutters bore their way into the coal, making a cut five feet deep, three feet wide and four to five inches high. The current is obtained from the "main entry" wires by means of the flexible armored conductors shown in the cut.

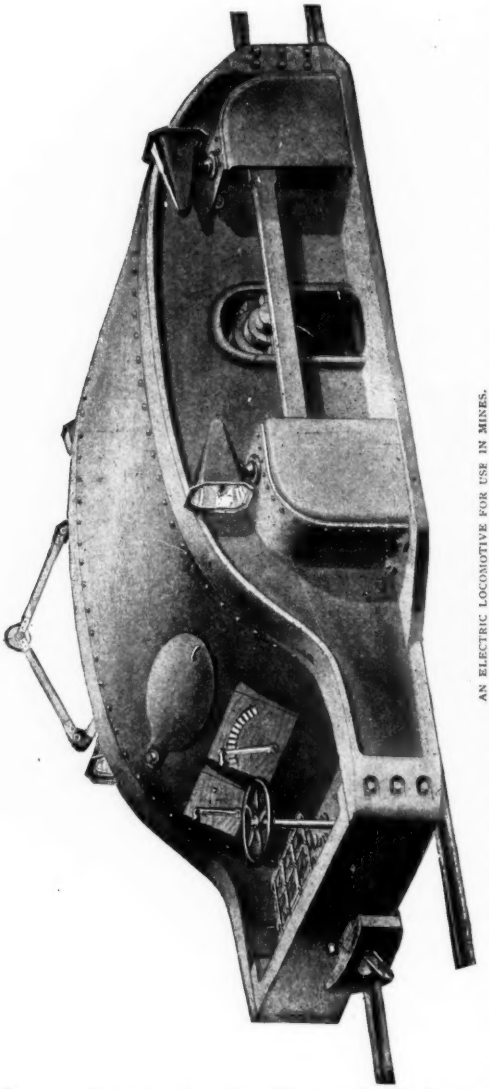
The electric firing of blasts, while usually accomplished by the use of small dynamos operated by hand-power, can be effected equally well by the ordinary power-transmission currents, and from a point either inside or outside the mine-workings, as desired.



AN ELECTRIC UNDER-CUTTING MACHINE.

In the department of "transportation," both below and above the surface, the electric current finds one of its chief fields of usefulness, owing to the considerations already mentioned. Local conditions must of course determine the type of apparatus to be used in any special case, but the electric locomotive, inclined and vertical hoisting, and telpherage systems already produced, sufficiently attest the advantages to be derived.

A special form of locomotive for use in mines having low-roof entries, is illustrated. It is of 60 horse-power capacity and is only 3′ 6″ high above the rail level. Not only is the motor itself practically waterproof, but the casing of boiler iron renders it almost impossible to cause mechanical injury to the apparatus under any ordinary circumstances. A trolley system similar to that used in street railway work is adopted in this case, a special trolley arm



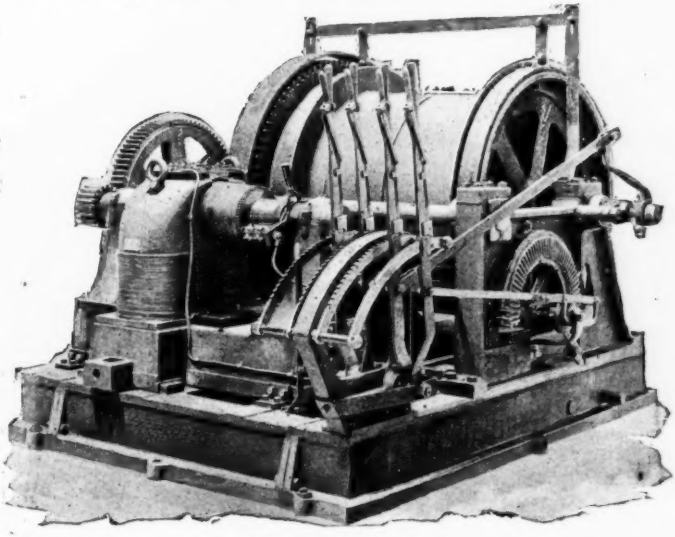
AN ELECTRIC LOCOMOTIVE FOR USE IN MINES.

being placed at the side of the locomotive and designed so as to render it unnecessary to make any change in its position when the direction of motion is reversed. The trolley wire is attached by properly insulated appliances either directly to the roof or sides of the tunnel, or to the timbers if present. Electric reflectors are provided, while in larger plants electric signals are also used to indicate the position of switches and show the position of loaded and empty cars.

A hoist of 35 horse-power capacity for incline or vertical work is illustrated, the special machine from which the view was taken being designed for a soft coal mine, handling "trips" of ten to fifteen cars on

a grade too steep to allow the use of a locomotive. The brake surface on this machine is unusually large, to avoid undue heating, while the electrical portion of the apparatus is especially designed for simplicity and compactness, and being mounted on one solid base special rigidity of the entire machine is secured.

We may now consider the excavated material as delivered at the surface, to be subjected to manipulation by various mechanical and chemical processes before being ready for final shipment. As this class of operations calls principally for the application of power to apparatus already familiar, we may pass it by without



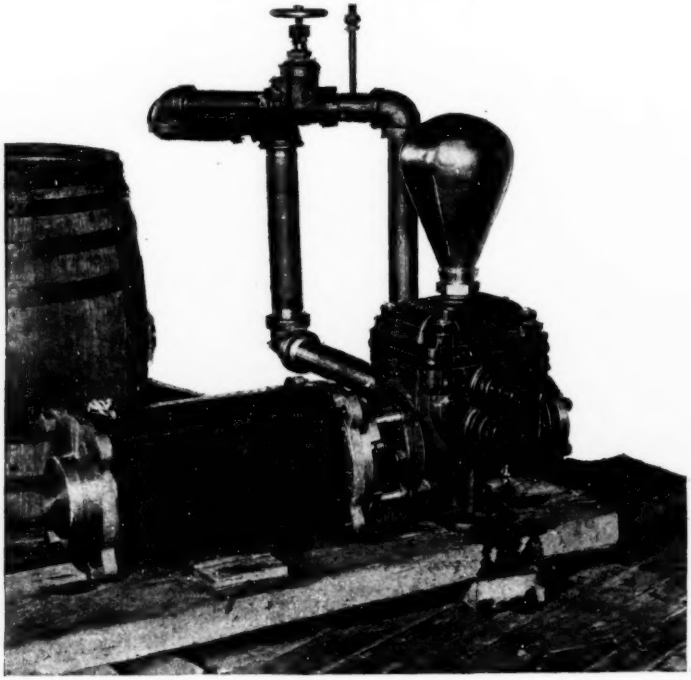
AN ELECTRIC MINE HOIST.

special mention, except to notice the increasing attention given to magnetic and electrolytic effects produceable by the very currents whose uses we have been discussing. The magnetic separation of iron ores is in itself a problem offering almost incalculable results to experimenters.

The fourth principal division noted above as "Contingent Operations" is no less important in its economic bearing on the subject than the applications previously discussed. For securing proper ventilation we may tap our main wires at any desired point above or below the surface, locating a fan either for "blowing" or "exhaust-

ing," and changing the location when desired without for a moment interfering with the operation of other machinery.

To many a mine operator the word "pumping" means a dividend or a deficit, and it is accordingly to this line of work that the attention of electric power engineers was early directed. A small pump at work in a Pennsylvania mine, keeping the workings clear



AN ELECTRIC PUMP.

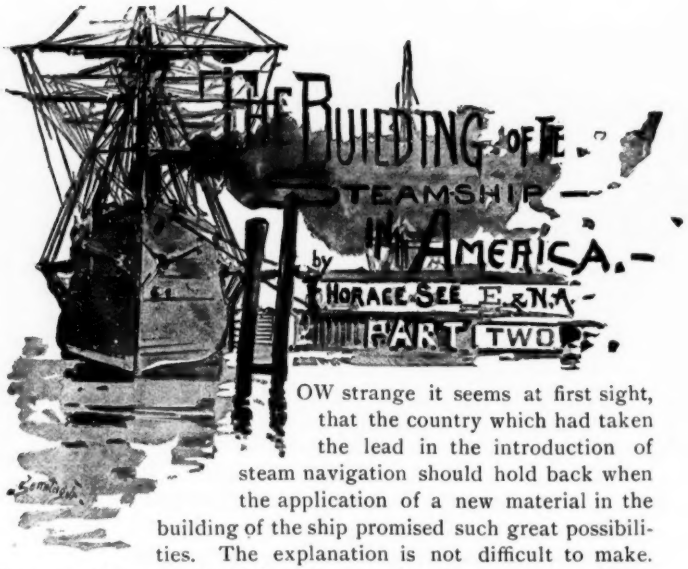
of water during important changes in the permanent system, we had hoped to illustrate, but the photograph proved imperfect.

Let it not be assumed from this that electric pumping apparatus is only available in cases where small quantities only are to be handled, and against low pressures. A pump is now in process of construction for a Western mine which will act against a hydraulic head of 1500 feet. An experimental pump on the same principle as that adopted for percussion drills, described above, is illustrated.

The extreme simplicity of this type of apparatus, having but one moving part, and no packings or bearings except in the water end, is sufficiently noticeable without further comment.

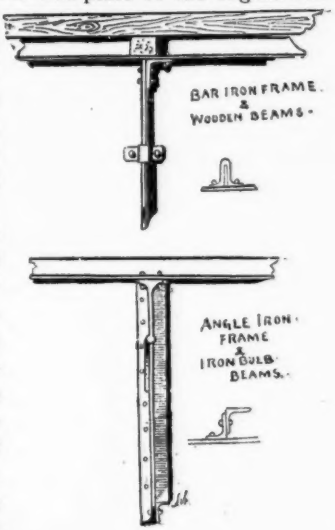
Electric lighting has within the past few months been introduced in a number of coal and metal mines, and a noticeable feature has been the attitude of the miners themselves toward the innovation. Except in a few instances, the men have not opposed the introduction of lighting as they have power apparatus, while in every case within the writer's knowledge, a few weeks' experience has made friends of the miners themselves, who seem to take pride in the fact that "their mine" has been the first in the neighborhood to adopt the "new fangled light." Although nothing on the market at the present time seems to offer just what is wanted for portable use, the lighting of shafts and main entries is such a simple matter that it must apparently come into general use in the near future. In fiery mines double globes should be used, but in the majority of cases simple wire guards are sufficient to prevent an excessive lamp consumption.

The above rough outline will serve to show in some slight measure the flexibility and adaptability of this new factor in mine engineering, as well as the more important uses to which it has already been applied. To the scientific student, as well as to the statistician, the advance in this department of work presages the most important results in opening up new mineral fields, and in a lesser degree increasing the value of those already known; while outside of mining operations, and consequently of the limits of this article, the possibility of utilizing nature's vast power supplies in units suited to the needs of the commercial world, may well enlist the best thought and energy of the engineering fraternity, and prove the best answer to the almost inexplicable prejudices still existing among some classes and organizations against what may truly be termed the Agent of the Nineteenth Century.



OW strange it seems at first sight, that the country which had taken the lead in the introduction of steam navigation should hold back when the application of a new material in the building of the ship promised such great possibilities. The explanation is not difficult to make. Timber being more plentiful and iron workers less numerous with us than in Europe, the superior advantages of iron were handicapped to such an extent by its greater cost and the greater difficulties of applying it to the structure of vessels, that we were backward in its use. Even when the experiment was made, and for a long time afterward, it but partly entered into the construction of the vessel. In all cases those who began its use were the engineers, not the shipbuilders of the day. These men displayed the same good judgment and skill in making the best use of what they could most readily obtain as their predecessors, the pioneers in steam navigation. Therefore they made the frames and skin of the vessel out of iron and the beams of wood. As bars and plates were about the only forms into which iron was then rolled, they alone were used. It was not until some time afterward that the mills engaged in making beams and angles of iron. The incorporation of bar iron into the structure of the hull was very skillfully done. As its form did not lend the necessary means for uniting it to the plates,

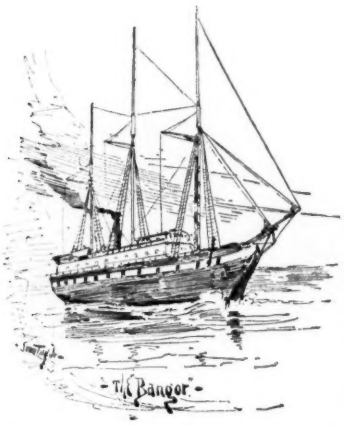
clips made of a lighter section of bar iron were used, two being generally riveted to each plate. Wooden beams were retained in the construction, and their incorporation effected by securing them to a lodger or resting plate of iron attached to the top of the frames and to the outside plating of the vessel. In the absence of heavy steam hammers, together with the uncertainty and expense of producing large and irregular shaped forgings, the stern-post of the screw propeller vessels, except the shoe, was made of cast iron. No engine foundation composed of plate and angle iron was prepared as now, but in its stead the bed-plate of the engine was continued down to the skin and provided with flanges for riveting to the plates. A number of other methods which have been abandoned, also unknown to-day, were equally interesting and evinced the same ability and skill in their application.



England led the van in the use of metal for this purpose, and to Aaron Manby, of the Horsley Iron Works, who in 1820 constructed at these works an iron vessel in sections and afterwards transported it to London to be there united in a dock out of which it was floated, is due the credit of being the pioneer iron shipbuilder.

His effort was followed by Fairbairn and Laird, the former at Millwall in 1836 and the latter at Deptford in 1837. Manby, Fairbairn and Laird were engineers. It is not astonishing that members of this profession should be the first to apply metal to shipbuilding, as they were workers in that material and consequently not only better acquainted with its merits but also possessed the necessary skill to handle it in order to make a surer success of the undertaking.

It was not until 1844 that anything was done in building iron vessels in this country. Then two concerns entered the field, being Reaney & Neafie, now Neafie & Levy, at Philadelphia, and Harlan & Hollingsworth at Wilmington, Delaware. The first



vessel was built at Philadelphia and named the *Conestoga*. It is not known why this name was taken, except that it may have been that the way the power was to be applied brought to their mind the Conestoga wagon. At this period and for some time afterwards the only way of transporting general merchandise between the eastern and the western portions of Pennsylvania, was by long wagons called Conestogas, hauled by several heavy horses. The steamer was 95 feet long over all and 19 feet breadth of beam, and propelled by two screw propellers placed at the bow and driven by a 16x16 inch engine. It is quite likely that the projector of this vessel had the Conestoga wagon in his mind's eye, and instead of a vehicle on land hauled by horses, had a boat built to be hauled through the water by screw propellers placed in the same relation to the boat as the horses to the wagon. The vessel built by Harlan & Hollingsworth was the first iron sea-going screw propeller ship built in the United States, and named the *Bangor*. She was 231 tons burthen, propelled by twin screw propellers of the Loper type, 8½ feet in length, placed at the stern, each being driven by independent engines having cylinders 22 inches diameter by 24 inches stroke of piston. The hull was 131 feet long over all, 120 feet long between perpendiculars, 23 feet breadth of beam and 9 feet depth of hold. The boiler was of the drop flue variety, placed in the hold. Messrs. Reaney & Neafie built five vessels in 1844, and Messrs. Harlan & Hollingsworth four during 1844 and 1845.

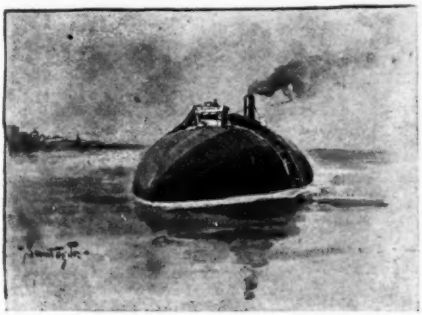
The United States Government entered the field in 1845 and built the *Water Witch*, an iron steamer which was the first of that material used in the navy. She was not a success, and was changed and remodeled so often that it would be difficult to say what she was or had not been. First she had a submerged wheel; then without any wheel she was used as a water tank; then she was fitted up with a screw propeller, and at last with a paddle wheel.

She was altered from a vessel with an outside skin of iron to one of wood. Finally, she was captured during the Civil War. Then her flag was changed from the Federal to the Confederate.

After 1845 a lull took place and no more iron vessels were built at the above yards on the Delaware until 1851. It was not, however, until 1858 that Messrs. Harlan & Hollingsworth built a veritable sea-going vessel; this was one of 1250 tons, named the *Matagorda*, and intended by her owner, Captain Vanderbilt, to be employed in the Gulf trade.

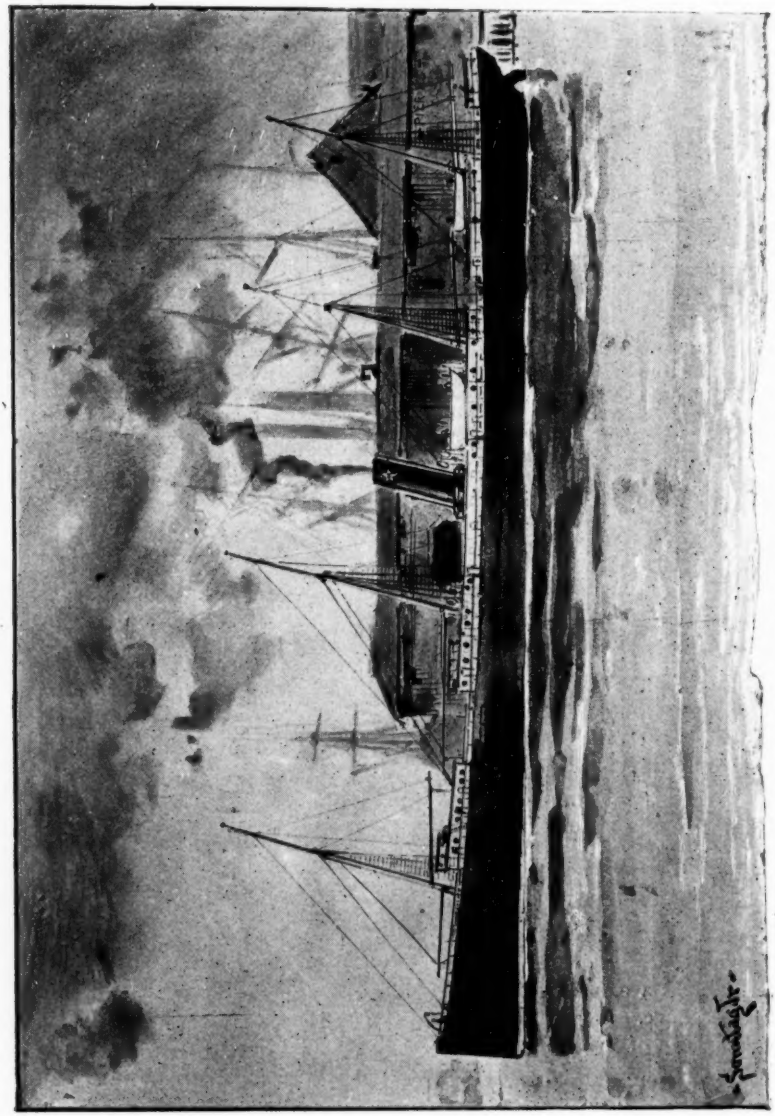
During this year iron ship-building was begun in Boston at the Atlantic Works, their first production being the *Voyageur de la Mer*, built for the Pasha of Egypt. She was 216 feet long, 37 feet beam, 21 feet depth of hold and of 1300 tons. The only peculiarity about this vessel was the attempt to apply the Corliss engine to screw propulsion, but it was not a success.

The ease with which iron could be fashioned into almost any form, was taken advantage of by the numerous inventors to construct vessels of peculiar shape, even in the early days of its application to ship-building. Ross Winans, of Baltimore, the locomotive builder and constructor of railroads in Russia, conceived the idea that the parabolic spindle was the correct form to give a vessel to insure strength, speed and what not. Having a large fortune to assist him he himself built such a vessel in 1858 to test the truth of his theory. It was called the cigar steamer, on account of its shape closely resembling that of its namesake. It would have been quite natural to have propelled this vessel with a screw propeller placed at one end. Such a simple agent, however, was not employed, but a wheel resembling a turbine was fitted and made to revolve on the outside of the hull about midships. It was driven by engines of the locomotive type. This vessel had no keel or stem, and as a natural consequence, failed on account of insufficient stability.



WINANS' CIGAR STEAMER.

Many of the coast-



THE STEAMER EL SOL.

wise steamship lines began their career by employing wooden vessels. One line, however, started out with and continued to build them of iron.

Mr. Chas. Morgan, who inaugurated the line which bears his name, was one of the latter. In 1858 he had the *Arizona*, an iron side-wheel steamer of 1100 tons, built at the yard of Harlan & Hollingsworth. The business of this line continued to grow and vessel after vessel was added, but not until 1875 was any change made in the manner of propelling them. In this year the keels of four vessels of 2270 tons were laid to be propelled by a screw driven by a single expansion engine. These engines have been kept in the ships until to-day when the one in the *Morgan City* is being removed to give place to one of the triple expansion type, by which it is expected to cut down the coal consumption from 28 tons to 14 tons a day, together with the gain of an increased freight capacity. These vessels were followed by the construction of others of increased size, until to-day some of them exceed 4500 tons. These great carriers of merchandise, there being no passenger accommodation, have such excellent facilities in the way of ports, hatches, derricks and hoisting machinery that their entire cargo can be discharged in less than eighteen hours. The *El Sol*, the largest and latest vessel of the line, built in 1890, is 405 feet over all, 48 feet beam and 33¾ feet depth of hold ; and is propelled at a speed of 14 knots by triple expansion engines of 3400 indicated horse power.

The steamship *Oriental*, built in 1860, by Messrs. Neafie & Levy, of Philadelphia, from the plans of John Baird, for the trade between New York and Havana, was the first ocean-going vessel in this country in which iron was exclusively used for frames and beams as well as plating. From this time wood was gradually dropped, although many vessels continued to be built of that material ; and even now a few wooden steam vessels are being turned out from the yards on the Kennebec and Delaware on account of their lower first cost inducing those with limited means to disregard the loss from heavy repairs which follows in a short time.

The first steamship in the United States to be fitted with compound engines, was the *Geo. W. Clyde* of 1470 tons; this took place in 1871. The engine was ordered with the intention of placing it in a former blockade runner, of limited capacity, to be altered for the purpose. On further consideration the vessel was deemed too small for the trade proposed, so a new but larger hull was eventually built for the engine. This hull was further increased in its

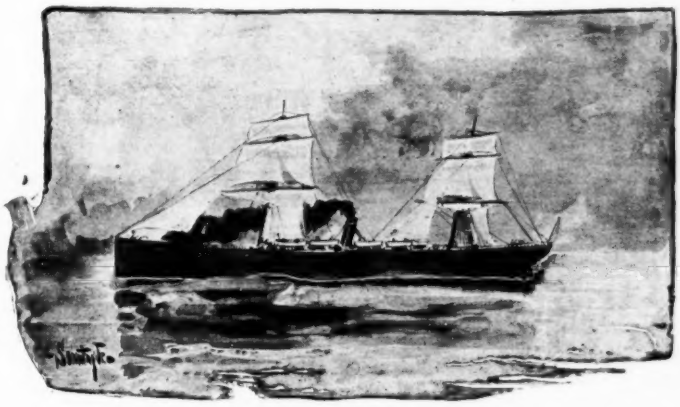
THE STEAMER CITY OF PEKIN.

carrying capacity by lengthening, so that the engine was finally called upon to propel a vessel two or three times larger than originally intended. This it has accomplished most successfully and is still actively engaged in trade.

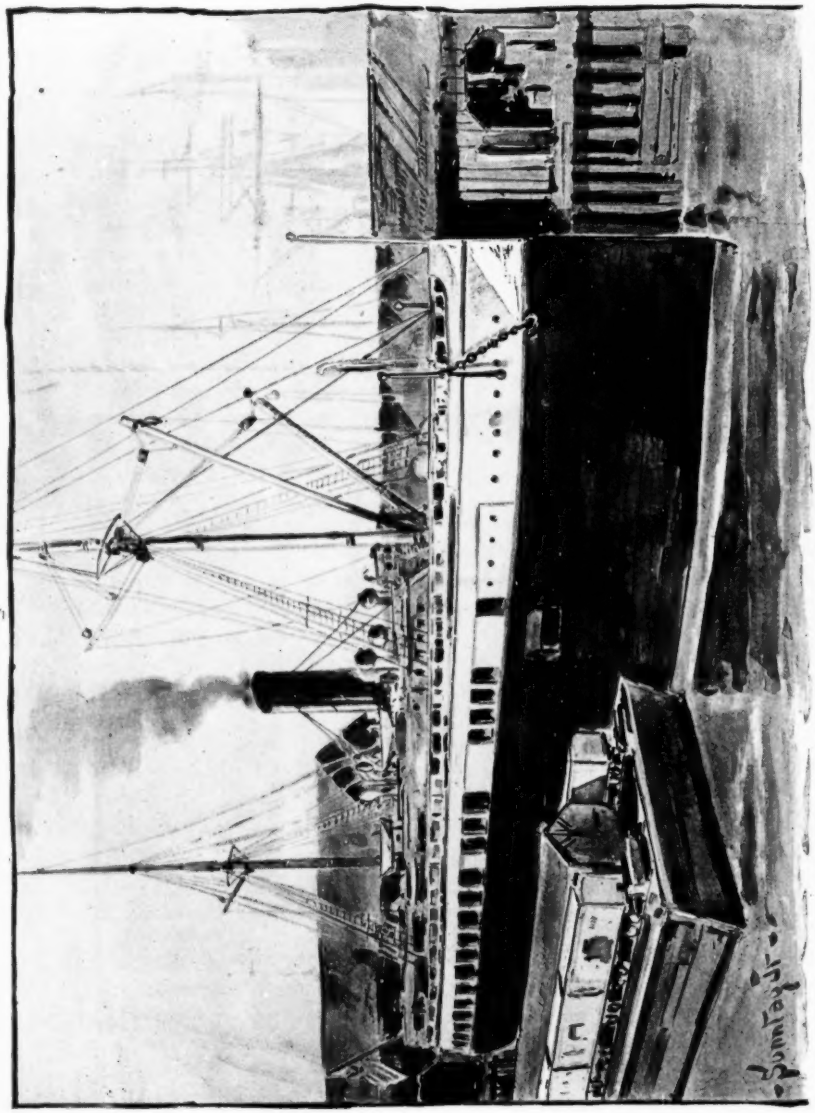
The Pacific Mail S. S. Co., which in 1872 had constructed for them four iron screw steamers with compound engines, named the *Acapulca*, *Colon*, *Colima* and *Grenada* of 3000 tons burthen, decided in 1874 to further increase the size of their vessels. They had Mr. John Roach build for them at Chester the *City of Pekin* and *City of Tokio*, vessels of magnificent proportions, having a length of 423 feet, a breadth of 48 feet, a depth of 33 feet and a gross tonnage of 5560. They excelled, in size, general construction and also in the style of their joiner work, anything that had been built in the United States, their passenger accommodations being of a superior character.

Although the Cunard line began building iron vessels for the transatlantic service in 1855, and continued to add others of the same material to their fleet, it was not until many years after the collapse of the American lines engaged in that trade that anything was done in this country towards their re-establishment. The citizens of Philadelphia, with public spirit, went bravely to work in 1872,

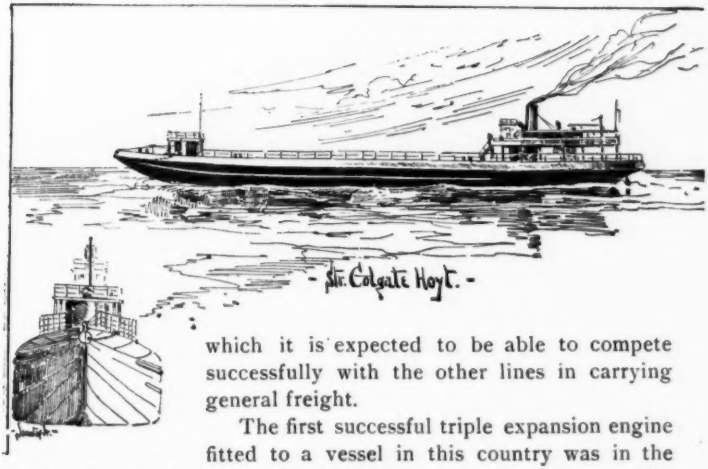
raised the necessary funds and built four iron steamers of the same dimensions for service between that city and Liverpool. The *Pennsylvania*, their pioneer vessel, was finished and made her first voyage in 1873. She was quickly followed by the other vessels of the line. They were all brig rigged, of a length of 360 feet, a beam of 42 feet, a depth of 33 feet and driven by compound screw propeller engines of 2000 indicated horse power. One of these ships, the *Illinois*, made the run between Queenstown and Cape Henlopen in 8 days, 10 hours and 34 minutes. Having been completed at a time when competition was keenest and rates much lower than when they were projected, the line from the start felt the reduction and barely met expenses. The addition to the competing lines of new vessels of much greater carrying capacity and of a little higher speed gradually robbed the line not only of its passenger trade, but eventually forced it to suspend altogether. Before this took place, however, the first class passenger accommodations were removed and the entire ship given up to emigrants and freight, but the larger carrying capacity of the new vessels of the other lines propelled by machinery operating more economically enabled them to transport a ton of freight at a little higher speed for a much less sum per mile. This told so heavily against the American line that they were finally forced, as before stated, to lay their vessels up. One has had new machinery added to her lately and now the others are being altered in the same manner, by



THE STEAMER PENNSYLVANIA.



THE STEAMER KANSAS CITY.

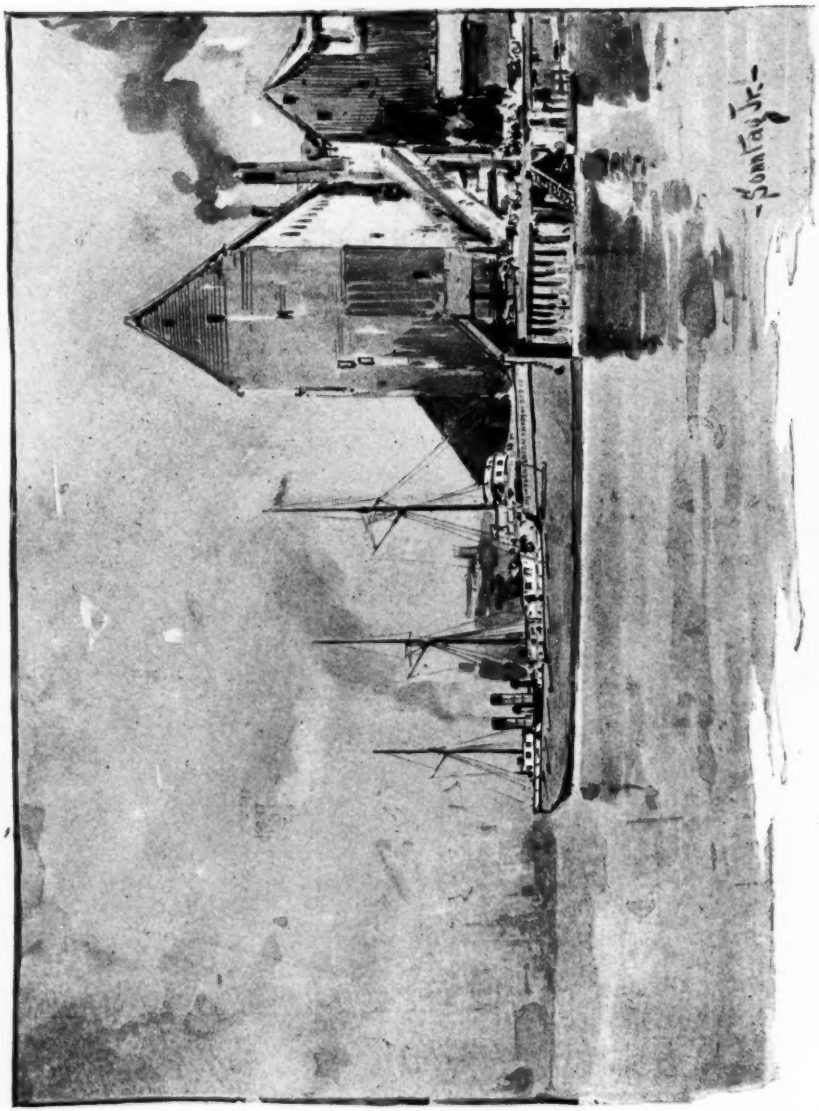


which it is expected to be able to compete successfully with the other lines in carrying general freight.

The first successful triple expansion engine fitted to a vessel in this country was in the yacht *Peerless*, built in 1885 by Messrs. Cramp & Sons. The boat was 146 feet long, 22 feet beam and 13 feet depth of hold. The engine had cylinders 17, 24 and 40 inches diameter by 22 inches stroke of piston. There was one boiler with 70 square feet of grate built to carry 170 lbs. of steam. Forced draught in a close fire-room enabled the boiler to generate sufficient steam to develop about 1100 indicated horse power or very nearly 16 horse power to each square foot of grate.

One of the latest high speed passenger steamers engaged in the Atlantic coastwise trade is the *Kansas City*, a screw steamer 327 feet long, 45 feet beam, 18 feet 8 inches depth of hold and 3679 tons. She was built of steel and iron towards the end of 1889, by the Delaware Shipbuilding Company for the Savannah S. S. Co. She is fitted with triple expansion engines having cylinders 33, 54 and 86 inches diameter by 54 inches stroke of piston. She is credited with being the fastest vessel which steams down the coast. Her passenger accommodations and joiner work are of superior quality.

The iron ship-building on the lakes must not be lost sight of in recording this industry. It has reached great proportions, and to-day the number of vessels built there for lake service alone exceeds that built for ocean navigation on the Atlantic seaboard. The builders are also entering the field of the Atlantic yards, and taking contracts for vessels to be employed on the ocean. Some of the



THE LAKE FREIGHTER HARLEM—LAKE ONTARIO.

vessels navigating these great inland seas are now built of large size with flat bottoms so as to draw but comparatively little water. One of the latest of these vessels intended for the transportation of general merchandise, is the screw propeller *Tuscarora*. She is 296 feet long, 40 feet beam, 25½ feet depth of hold and 2386 tons, propelled by triple expansion engines having cylinders 24, 38 and 61 inches in diameter by 42 inches stroke of piston. She was built in 1890 for the Lehigh Valley Transportation Company by the Globe Iron Works, of Cleveland, Ohio, and has eight water ballast compartments of 800 tons capacity.

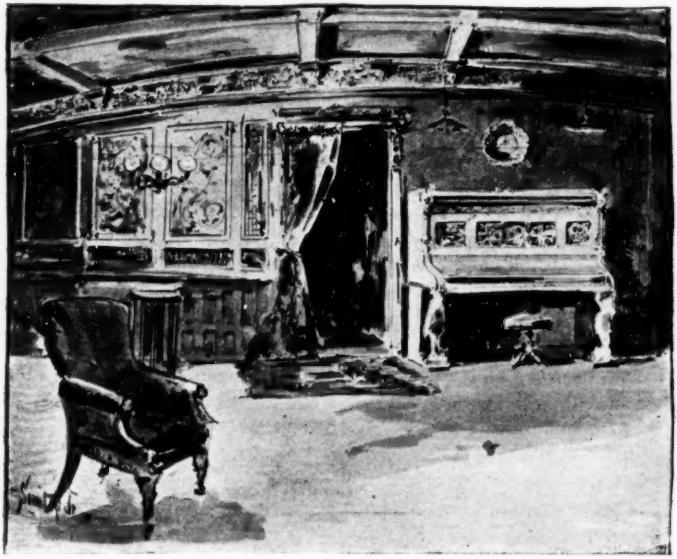
Another lake screw propeller of about equal capacity is the *Harlem*, built by the Detroit Dry Dock Company for the Western Transit Company. She is 288 feet long, 41 feet beam, 22 feet 7 inches depth of hold, of 2299 tons, and propelled by triple expansion engines having cylinders 23, 36 and 62 inches diameter by 48 inches stroke of piston.

A modification of the cigar steamer has lately been developed on the lakes by Captain McDougall. They were first introduced as barges to be towed in fleets of two or more. Their form differs from that of the cigar steamer in having a flat bottom and turtle back top extending very nearly the entire length of the vessel, the ends being the only parts which approach the shape of the cigar. The *Colgate Hoyt*, one of these vessels, has been fitted with engines which drive a screw propeller located at the stern. She is a large carrier, having taken on her first trip 2800 tons of iron ore on 15 feet draught. Her dimensions are 280 feet over all, 36 feet beam, and 22 feet moulded depth. The quarters for the officers and crew are in a cabin above the deck, resting on three turrets in the centre and twelve ventilating pipes at the side of the vessel near the stern.

The great wealth which has been accumulated in our country during the last quarter of a century, is displayed in the numerous costly and magnificent sea-going yachts built for the pleasure and comfort of man. Although England possesses a more numerous fleet of such vessels than can be found on this side of the Atlantic, we can point with pride to a few which excel hers in speed. The most prominent one of this character is the *Atalanta*, built by Wm. Cramp & Sons for Mr. Jay Gould. This beautiful and handsomely fitted vessel stands pre-eminent for her great speed. Although built in 1883, her record up to the present time has not been excelled by any steam yacht afloat, having maintained a speed of 17¼ knots for a period of six hours. At the end of this time her ma-

chinery was in as good condition as at the start and, no doubt the performance could have been continued for a much longer time. She is 227½ feet long, 26 5/12 feet beam and 16 feet depth of hold. Her propelling machinery consists of a compound engine having cylinders 30 and 60 inches diameter by 30 inches stroke of piston, supplied with steam from two internally fired fire-tube boilers, and developing 2000 indicated horse power under forced draught. She is fitted throughout with the electric light. Her crew consists of 38 men.

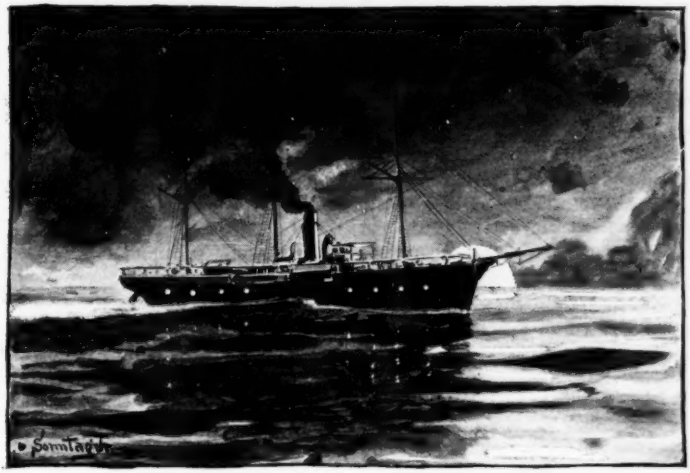
The high speed of the *Atalanta* has been attained through the



MAIN CABIN OF THE STEAM YACHT ATALANTA.

superior performance of her machinery brought about by the adoption in its construction of a grade of workmanship which allowed the engines to be run continuously, without heating, at a high rate of speed for an unlimited period of time. The work of the mechanic has been the prime factor in reaching this important end. His skill has been shown not in the employment of complicated mechanism for obtaining imaginary results, but in the use of a simple compound engine with the ordinary link motion, the whole

properly designed and perfectly constructed. The development of the economical ship, whether of high or low speed, will have to be carried out on this line. Material of reduced weight but of superior quality and strength will have to be adapted with equal skill to enter into the construction of the hull and machinery. The compound system will have to be extended still further by the use of higher pressures, and the expansion of the steam in four or more cylinders of different diameters. The workmanship throughout will have to be of a higher grade made possible by advanced methods and the more general introduction of improved tools for producing everything that enters into the construction of the hull, engine and boiler.



THE STEAM YACHT ATALANTA.

ENGINE-ROOM CHAT.

By Col Loquial.

JURGESEN is a "natural born" growler. He is a "child of nature improved by chance" in the art and practice of grumbling. He can express dissatisfaction more different ways and about more things and more kinds of things, than any other man of my acquaintance. If it isn't one thing, it's another. From the office boy up to the superintendent, and from the cashier down to the night watchman, no one pleases him. From the method of keeping books, to the way they pickle castings, from the kind of coal they use in the cupola, to the way deaf Johnson drives the yard mule, nothing suits him. The other day he got down into the engine-room and opened down on Henry. The main belt was too loose. (Henry had just loosened it because the bearings had been melted out by the tension put on it by the last engineer.) The cylinder oil was too heavy. (Henry had had to get a heavy oil to stand the superheat of the steam from the new boiler.) The out-board bearing was too loose, and the water was too high in the boiler, and that suction chamber on the fire-pump was a needless expense, and * * * Henry just put on his coat, with never a word, and quit. It was Monday morning, and he didn't mind the small loss of pay.

* * *

You need not tell me that any engineer who has a crust of oil and flour all over his engine, outside, can make a good showing of that engine when it is opened out and taken down. The "outward and visible sign" is not always a sign of the "inward and spiritual grace" in engineering as in moral matters, but as a rule, if the outward and visible sign be lacking, the much to be desired inward qualities are gone in at least the same proportion. Now, I'd bet you my head against a burnt match that yon engine is spavined, quarter-cracked, broken-winded, and all the rest of it. The wrench and spanner have seldom if ever touched it. The crank-pin brasses are probably touching and the pin wobbling around between them with a sun-and-planet motion. There is probably a steam leak from one side of the piston to the other—and as for the stuffing-box, it speaks for itself on every stroke. There is just one chance in two that the valve opens out after cut-off, and blows live steam through into the exhaust. An engineer who gets his engine crusted like that isn't worth sheol-room. Some time that governor-belt will break and the fly-wheel will go on a tour of investigation of the surrounding country. Then you may wish, if you are in a wishing condition, that you had hired an engineer instead of a mere starter and stopper.

* * *

Gum is a good thing to make belts out of, but it is a poor lubricant. That last oil you got is as full of gum as an old cherry tree in spring. It doesn't get between the wearing surfaces. Try it to mix with white lead or tallow to dope some bright work that you are sending out, but don't insult your bearings with it. It would be dear at four dollars a barrel.

* * *

That main belt makes about six times as much noise as the engine itself. It is too tight; and not only that, it is tighter on the right edge than on the left, and nothing but the crown of the pulleys keeps it central. Slack it up and straighten it out. You are overstraining it; and more than that, you are making your engine wear all out of shape, as the shims in the quarter boxes show. I can run that same engine and belt with three-fourths the present friction, and maybe with one-half—say three-fourths. There is probably twenty horse-power consumed at present in friction out of 120 gross developed. Now a saving of one-fourth of that will be five horse-power, which, running only ten hours a day, 300 days in the year, will cost

about $120 a year. But as you run an average of twenty-two hours a day, those five horse will cost you at least $264 each year. Hadn't you better slack it up a bit?

* * *

Yes, that dynamo runs irregularly, and will continue to do so just as long as you run that small pulley on it. You are belting from a 36-inch to a 12. Now just suppose you say 20 on the dynamo; then a 60 on the jack-shaft will do the work with the same theoretical speed and less slip. There is room with those hangers; and even if there wasn't, bolts are cheap and blocks plenty.

My word for it, increasing the pulley size will decrease your light-jumping.

* * *

I don't care how much oil you put in your steam, you needn't imagine that all of it is going to be distributed over the cylinder walls. It isn't in the nature of things. Now, for that high speed horizontal engine you want positive lubrication and plenty of it; you want the oil put right on the piston head on the upper side, and it will find its way to the bottom.

How is that to be done? By a Yankee trick, my friend. Drill a small hole the full length of the piston rod. Drill down in the head to meet it—say two or three radial holes, five degrees apart. Mount on the cross-head and in connection with the bore in the rod a piece of pipe half as long as the piston diameter, and put your oil-cup on that. Fill your cup and the oil will run out of the small holes on the top of the piston head. The top line of the piston head and of the cylinder bore will be oiled by actual contact. The rest of the circumference of each will be oiled by gravity. As the steam-chest is on the side, where it should be, there will be no trouble at all about the oil getting out. Slosh it in, plenty of it, and use it over and over again. See that your stand-pipe is always kept full, and the whole thing is done. I have used this arrangement on a short-stroke engine making 720 turns a minute, and know what I am talking about.

* * *

The reason why your engine will not run steadily is as plain as the nose on your face. The fly-wheel is too light for the variations in load and in steam pressure. When your load is light you have more steam than you need; but just about the time when those dye tubs are pulling the steam down, the shoddy-devils are loaded up to their full tearing capacity. The principal remedy is more fly-wheel; not necessarily a heavier one, but one of greater diameter. Put the iron out away from the shaft, so that it will have some sling to it. If that interferes with your belting arrangements, or if there is not room to put in the layer-wheel, then get one with wider rim; and if that is not convenient either, then thicken the rim all you can. It may take you a few minutes more to get up speed, but it will be worth the time to get smooth steady running.

* * *

Oh, I know that man. He used to run the engine over at the lead works. He knows it all. A very superior kind of a man to have. His education has been got exclusively at other people's expense. He has generally got only about one point at a time; then he has found it necessary to take a change of air and surroundings. He tried the effect of excessive cushion in his last place but one, and as it was a Corliss engine and the valves wouldn't lift, and as the clearance was pretty small, he bunged up the whole engine in about four minutes by the watch. You can't teach him anything. He says that he is a "natural born engineer," and "don't want no advice about his own job." I would sooner pay him his wages to keep out of my engine-room than allow him to run the engine free.

* * *

Yes, I see that the Pennsylvania R. R. is going to abandon bright work on its engines; and I prophesy a return to the former order of things in all cases where an engine has only one crew. Of course, where there are two or even three crews to a machine, there will not be the same incentive to rubbing up and brightening all around and under; but for one crew engines, give me something for the men to take pride in.

Some men are never satisfied to let well enough alone about their engines. Between the mossback who never learns anything, and the man who is forever trying some new adjustment, at the owner's expense and without consulting any one knowing at least as much as himself, there is really not much to choose. Some engineers live with a monkey wrench in their hands. When they die they'll want to be giving their coffin-lids more lap, and will never be contented if their headstones haven't a little negative lead to the north-east. Experiments are all very well if there is a record kept of them and of the results produced; but just cut-and-try and get-out-of-the-window-if-anything-breaks never makes either a good engine or a good engineer. Shapleigh's mill is shut down enough half hours at a time to make one day in a month, just waiting on that smart runner of his to "take her up a little more" somewhere.

* * *

Great Scott! Here you are going to lace that main belt again just because it is commencing to slam against the edges of the hole in the partition wall. That is three times in two weeks. Why don't you get a cross-cut saw and a cent's worth of gumption, and cut the hole larger so you can run the belt slacker? You remind me of the man who when his cat, which had for months been coming through a hole that he cut in the barn-door, had kittens, cut a smaller hole beside the first one for the kittens to come through. You keep the belt as tight as the Wall Street brokers say money is, and every week or so you want half the hands in the place to knock off work and help you take a piece out and draw it up.

I've heard of men who didn't know enough to come in when it rained; why, you don't even know when it's raining!

* * *

As MacGregor was footing up his profit and loss the other day, there entered into his office two self-confident men, one young, the other middle-aged, both with a "make way for Liberty" air. As Mac paused at the foot of a column of figures and looked up, one of them, the spokesman, in an impressive and lordly manner, calculated to bring Mac upon his knees and freeze the blood in his veins from very fear, said: "We're walking delegates."

Did Mac extend the hand of fellowship and tender the hospitalties of the place, the while quaking in his generous gaiters?

Not Mac.

Quietly removing the pencil from his mouth and turning to his balance sheet, he simply and decidedly met the enemy with these words;

"Well, *walk!*"

That was the end of the interview. The engineer who reserves the right to belong or not to belong to as many societies as he pleases, still manipulates the throttle and the oil-can at MacGregor's.

* * *

Dobson's engineer is like a rack comb:—all back and teeth. He never has a pleasant or an approving word for anybody or anything. He is sarcastic to an extreme, and no one is safe from the keen edge of his oval stiletto. When his neighbor dropped in for a moment to pass the time of day, and talk about his new rope drive, the man of sarcasm asked him if he had decided whether to use Clark's or Coate's cotton for his main belt. When the carpenters were putting up the new "balloon frame" drying house, he called one of them to him and said that they were the smartest carpenters he had ever seen. "How so?" said the "wood-butcher," with an eight-inch smile and an expectant air. "First men I ever saw who could drive a nail in a match" quoth the throttle-twister.

Now that sort of thing don't pay. It is a direct business injury to Dobson, if you look at it rightly. A man with that unfortunate habit (it is a vice, by rights, and as such entitled to be punished) can form no friendships and have no improving conferences in reference to his avocation. He will know less in June 1901, than in June 1891; less sarcastic engineers will know more, if they live so long, and if they die before that time they will have some friends to give them a decent burial.

The Relative Merits of Portland and Rosendale Cements have been the subject of debate between correspondents of our very able contemporary *Engineering News*. Such debates are apt to bring out interesting facts. Mr. Albert Scull, one of these correspondents, having charged upon Portland cement that after an age of two years it becomes weaker, and that Rosendale cement is superior in this respect, Mr. Howard Fleming opposes this statement by some facts interesting to both architects and engineers. He says the record of Portland cement used for concrete construction and the manufacture of artificial stone in this vicinity for the past quarter of a century and in England since 1850 completely refutes Mr. Scull's assertion, for not only have heavy foundations and dock walls in different parts of the world stood the disintegrating effects of water, but the artificial stone constructions in Central Park, New York, in Prospect Park, Brooklyn, and elsewhere have weathered and are more perfect to-day than if built of natural stone. He adds that the Portland cement pavements that have been properly laid during the last ten years are silent witnesses that they stand heavy traffic and do not disintegrate; whilst some pavements that were first made with Rosendale cement have long since passed into innocuous desuetude. Rosendale is a satisfactory material for certain work, but the increasing employment of Portland cement is due to its economy for rapid construction and ability to carry a compressive load. A caution against the use of the low-priced Portland cements (which are such only by virtue of the labels on the barrels) concludes Mr. Fleming's interesting letter.

A New Artificial Stone, compounded of iron, sulphur and silicon, with addition of foreign matter, and which appears to be a concrete as much or more than a chemical compound, has been described in the Journal of the Association of Engineering Societies by Mr. Herman Poole. This stone possesses some valuable qualities if all the claims made for it by Mr. Poole can be substantiated by protracted use. He describes it as normally having a dark slate color, varying somewhat with the manner in which it is dressed, but the color can be somewhat modified by the introduction of pigments. Successful imitations of various colored brick and sandstone have been made. It has about the hardness of ordinary bluestone and can be worked by the usual stone-cutting tools, turned in a lathe or planed. The tensile strength is from 650 pounds to 1200 pounds per square inch, and under compression it endures from 9000 pounds to 12,000 pounds. Its specific gravity is about 2.6. It melts at about 300° Fahr., very slowly. It does not deteriorate under exposure to the weather. As it can be melted and moulded, it is applicable to a great variety of uses to which stone cannot be put, and particularly so for large castings, such as pipes for sewage, etc. Architectural forms can be very conveniently made from it in position if needed. For culverts and bridge foundations, the perfect smoothness, of which the surface is susceptible, is advantageous in lessening water friction.

The Setting of Plaster of Paris as relates

to the time required for it to set and its hardness after setting depends upon the mode of calcining. The subject has recently been very thoroughly studied and discussed at length in the *Chemical Trade Journal*, from which we summarize the following conclusions immediately applicable to the use of this material in ordinary construction. The hardest material is frequently obtained from the quick-setting plasters, but for certain purposes this rapidity in setting is of great practical inconvenience. It was formerly supposed that plaster prepared by baking at a temperature above 300 degrees loses completely its power of setting. Later observations, however, as those of Landrin, negative this view. Between 300 degrees and 400 degrees Landrin obtained plasters setting almost instantaneously when mixed with a small amount of water. When the temperature employed approached 400 degrees, the set plaster was softer, but the setting still took place quickly. These observations appear to show that the change to anhydrite is a very gradual process at temperatures below a red heat. In baking it is necessary that there should be a better control over the temperature, since if the heating be carried too far the plaster, if not partially dead burnt, will set too quickly. Direct contact with the fuel or the flame should be avoided, since this reduces some of the sulphate to sulphide of calcium, the presence of which is in many respects objectionable. Plaster from granular crystalline varieties of gypsum is preferable for moulding purposes to that from the fibrous kinds. After grinding, in rubbing the plaster between the finger and thumb no particles of grit should be perceptible. The material should be an impalpable powder.

Excavating in Quicksand, was discussed at a recent meeting of the New England Waterworks Association, and Mr. Albert F. Noyes, recounted an experience which is both interesting and instructive illustrating a method adopted by him in a case occurring in his practice. The excavation was fifteen feet deep, sixty feet long and eight feet wide, and near buildings. He said:

"If the excavation were made in the ordinary way, a settlement of the foundations would be likely to occur, so I adopted the following method; in many cases, it could be used to advantage in excavation. Usually below these veins of quicksand are veins of a coarse material which form ready conductors for the water, and the vertical distance through the quicksand is usually less than the horizontal distance; the ground water has the least resistance in the vertical direction, and tends to soften and take up the quicksand with it. If the water is drawn out, or the water level lowered below the bottom of the trench, this fine material becomes compact, very much like clay, and excavations can be easily made with perfect safety and the use of a light sheeting. I used 14 pipes 1½ inches in diameter, and these were driven equidistant about the excavation to be made, with the ordinary perforated well-point, having attached outside a fine-mesh brass screen. They were driven into a stratum of coarse material from 35 to 50 feet below the surface of the ground. The pipes were ganged together and attached to a common plunger pump, and the water was drawn down. I might state that the normal level of the ground water was within some 3 or 4 feet of the surface of the ground, so we had to draw the ground water down some ten or eleven feet. We found by test tubes outside of the gang that we could readily hold the water to a level, which insured the excavations being made without any difficulty whatever; in fact, the banks were dry and the lower portion of the excavation was very firm."

"Irrigation Development" and "Irrigation in Southern California" are respectively the titles of two books, for which we are indebted to the courtesy of Mr. Wm. Ham. Hall, C.E., of San Francisco, who, as many of our professional readers will know, was the State Engineer of California, appointed under an act passed in 1878, to investigate under direction of the Governor "the problems of irrigation of the plains, the condition and capacity of the great drainage lines of the State and the improvement of the navigation of rivers." Civil and hydraulic engineers will at once comprehend the magnitude of the work thus briefly defined in the above quotation from the act referred to. Appropriations of money for carrying on the work having been made from time to time by the California Legislature, the surveys were carried out in accordance with the

act, and the able report of the State Engineer embodied in two volumes, embraces all that was done up to October 1, 1888. These volumes were printed by the State, under the law, for sale, the price being $3 per volume. In a courteous letter under date April 13, 1891, Mr. Hall defends himself from any charge of seeming "want of professional courtesy in not having sooner sent copies of his report to the engineering press," by the statement that he was unable to obtain copies allowed him by the Legislature any sooner owing to delays in the printing and binding. This, while an injustice to Mr. Hall, has also been a loss to the public, as a very cursory glance over the report will convince any one that it is a highly important contribution to civil and hydraulic engineering, and to the topography of the great State of California. We regret that our very limited space precludes any extended notice of the contents of the report. Mr. Hall will please accept our thanks for sending us these valuable works.

Irrigation Maps made by Mr. William Ham. Hall, as State Engineer of California, have been lithographed, and may now be obtained of the Secretary of State at Sacramento, as follows:

1st. *Topographical* and *Irrigation Map* of the *Great Central Valley of California* (Kern, Tulare, San Joaquin and Sacramento Valley combined). Scale, 6 miles in the inch—2 sheets, price 50 cents per sheet.

2d. *Topographical* and *Irrigation Map* of *San Joaquin Valley* (including Kern and Tulare). Scale, 3 miles in the inch—4 sheets, price 25 cents per sheet.

3d. *Detail Irrigation Maps of San Joaquin Valley* (Kern, Tulare, Fresno and Merced irrigations). Scale, 1 mile in the inch—10 sheets, price 25 cents per sheet.

4th. *Detail Irrigation Maps* of *Southern California Valleys* (covering Los Angeles and San Bernardino irrigations). Scale, 3 miles in 4 inches, 12 sheets, price 25 cents per sheet.

5th. There are also, *A Rainfall Distribution Map of California* and a *Drainage Area Map of California;* one sheet each, at 25 cents apiece.

6th. Nine sheets of the *Great State Map of California;* scale, 4 miles in one inch; have been lithographed, but are not quite finished for sale and have not been printed off.

This enumeration will indicate the comprehensive character of the work performed by Mr. Hall, better than any limited notice of his report could do. We are informed by him that the prices named merely cover the cost of lithographing, packing and postage.

Upon the Present Status of Compound Locomotives a correspondent of the *Railway Master Mechanic* writes in a very level-headed fashion as follows:

"With nearly 1000 compound locomotives in use abroad, and several in this country, the experimental stage may be considered as passed. The report of the railroad commissioners of the State of Massachusetts for the past year, gives the total train miles 45,448,365 and the cost of fuel 9.8 cents per mile, which would give as a total $4,454,939.77. The number of locomotives is given as 1643. If two-thirds of the locomotives and of the service had been compound, saving 15 per cent., the amount saved would have been $445,493.97. Dividing this sum by the number of locomotives supposed to have been changed to compound, namely, 1095, the result is $406.84, or about the cost of the changes, saved in one year. The locomotives would do better service after the changes were made, would be more durable, would throw less dirt, and give less of that American delight—noise."

The Advantages of Oil as Fuel for War Vessels, set forth in the May number of THE ENGINEERING MAGAZINE, have been exemplified in the chase of the Chilian vessel *Itata* by the U. S. Cruiser *Charleston*. It has been estimated that neither of these vessels can carry coal sufficient for more than a week's run without fueling, and even such a run cannot be made at full speed. With oil as fuel, twice the distance now possible to either vessel could be made without stopping. For swift cruisers at least, it seems plain that the use of oil would result in greatly increased efficiency when in active service, especially so when the saving of time in fueling is also considered, and when, as in the case of the *Itata*, a saving of a single half-hour might be the determining condition of success.

The Chicago Institute of Civil Engineers is the new name adopted by the association hitherto known as the "Western

Society of Engineers." The change of name was made at the meeting of the society held on the evening of May 6. It is stated that this society has 375 members. At the meeting referred to Mr. L. E. Cooley read a paper in continuance of a discussion of the feasibility of a project to construct canals whereby boats drawing twenty feet of water could sail from Chicago to the Atlantic sea-board, on which at the preceding meeting a paper had been read by Mr. E. L. Corthell. He thought the project of providing such a waterway to the Gulf of Mexico, perfectly feasible, but contended that the connection of the Atlantic sea-board with Chicago would involve far greater difficulty. He did not believe that such a waterway would be so much a rival of railways as an auxiliary of commerce. Considering the immense traffic to the sea-board and the disadvantageous position of the St. Lawrence channel, he believed that the Erie Canal would long continue to be of great commercial value. In his opinion the best physical and commercial route was the one by the lakes, Niagara, the St. Lawrence, Lake Champlain, and the Hudson, and later by the Mohawk Valley. So far as Chicago was concerned he thought it in the worst possible position to derive advantage from a great water route. Its harbor was only available for vessels of a draft of sixteen feet, and to accommodate larger vessels the harbor would have to be literally remade.

The Survey for the Dakota, Wyoming and Missouri River Railroad, was commenced on the 4th of May, by a corps of engineers and assistants, beginning at a point near Rapid City, whence the survey will be extended westward.

A New Bridge at St. Louis, Mo., built under the charter granted by the Congress twenty years ago to the East Carondelet and St. Louis Bridge Association will be at once commenced and pushed with vigor to completion. At least this is asserted by the Detroit *Free Press* and other Western papers. The charter has been transferred to the syndicate of which Mr. Jay Gould is understood to be a member. It is to be a high truss bridge, located six miles below the site of the famous Eads Bridge.

The Amount of Power which a high-grade turbine water-wheel is capable of transmitting, is demonstrated by a New American Turbine Wheel, manufactured by the Dayton Globe Iron Works Co., at Dayton, Ohio, and in use at Niagara Falls. It is forty-two inches in diameter, and under a head of one hundred feet is developing two thousand horse power. The same company has just filled an order for eighteen wheels which under a low head develop from fifteen hundred to two thousand horse power, for one establishment in Wisconsin.

A Very Costly Job the change from horse to cable-propulsion on the Broadway line in New York City is turning out. In some places the hard rock has to be chipped out, as the number of steam, gas and water pipes underlying the street is so great that blasting is out of the question. A competent civil engineer has estimated the cost of this cutting to be not less than $50 per cubic yard. The cost of removal of pipes which the change will necessitate is also estimated by the same engineer at not less than $2,000,000. It is stated that the management of the road has paid $100,000 to a steam-heating company as the purchase price of obstructing steam pipes, in order to allow the construction of the cable work to proceed without that obstruction, and these pipes only represent a very small part of the similar obstructions which will have to be encountered in the completion of the work. Enough of difficulty has already developed to demonstrate that it is a Herculean task the company has undertaken, and while the change will greatly benefit the public, it is, in view of the probable cost of the change, doubted by some whether it will be remunerative to the stockholders.

An Inclined Railway Tunnel, which according to statements made in London journals is the first of its kind ever constructed in England, has been excavated at Hastings to afford a quick and easy passage from the sea front to the West Hill for residents and visitors. The tunnel has a length of 402 feet and an incline

of 1 in 3. Its width is 19 feet, and height 18 feet. The total rise from the platform for passengers at the bottom to the platform at the top is 170 feet. The railway track is double and the rails are of steel resting on wooden stringers set in cement. The cars are constructed to hold sixteen persons, and are carried on angular wrought iron frames to which the carwheels are journaled, and in such manner that the floors of the cars are level. The cars, of which there are two, are connected by cable, so that the descent of one assists to haul up the other.

The Tunnelling Age is a name for the present period which suggests itself in view of the number of tunnels excavated within the memory of the present generation, those now in progress, and the new ones projected. Sir Douglas Fox has just forwarded an exhaustive report on the plans for constructing the proposed tunnel between Prince Edward Island and New Brunswick. He declares the scheme to be practicable, and estimates the cost as follows: Tunnel of 12 feet to be operated by an electric motor, $5,000,000; tunnel 18 feet, to be operated with American rolling stock, $11,000,000; tunnel of 16 feet, $10,000,000. The tunnel will be chiefly constructed of brick. On the 30th April, work was initiated on the giant tunnel destined to connect Windsor and Detroit. The occasion was one of great interest, and large delegations from both Windsor and Detroit were present. Chief Engineer Hawks delivered a brief but interesting address in which he stated that the tunnel plans require on the Windsor side to the water's edge, a cut of 2100 feet; on the Detroit side 1500 feet, and a distance under the river of 2633 feet. Open cutting to the extent of 3600 feet would have to be done. The diameter of the tunnel on the inside would be 27 feet, and it would be the only double-tracked tunnel in the world. The interior would be a steel tube with a depth of six bricks laid on the inside and covered with cement. On the 9th of April a delegation of the most substantial business men of Milwaukee visited the Wisconsin Legislature in the interest of the Wisconsin Central railroad entrance to Milwaukee for which a tunnel is desired. The latest subaqueous tunnel completed is the great St. Clair Tunnel on the line of the Grand Trunk Railway and connecting Sarnia, Ont., with Port Huron, Mich. Seventy trains will daily pass through this tunnel which, though only 6000 feet long, is in many other respects remarkable. The cutting is almost entirely through blue clay under the St. Clair River, which has a 40 feet channel over the tunnel. The method adopted was the use of steel shields with sharp cutting edges pushed ahead constantly as the excavation proceeded and the lining of the excavation with huge rings of cast-iron. The work proceeded from each terminus of the tunnel toward the centre. The cast-iron rings each weigh about 6½ tons, and each is formed of thirteen segments connected to each other by bolting. Hydraulic jacks were used to push the shields forward into the clay. Air, compressed sometimes to 40 lbs. per square inch, was employed to prevent the water from forcing its way into the tunnel while the work was in progress. The entire excavation was completed on the 30th August, 1890, substantially in one year from the beginning, and it is mentioned here because its successful accomplishment undoubtedly led to the projection of the new tunnel just begun at Detroit, which is to be much longer than the Port Huron tunnel, or 8433 feet, besides 3600 feet more in open cuttings, as stated by Chief Engineer Hawks. Lastly comes news under date May 14 that the first section of the Niagara Falls Tunnel will be started within thirty days. The canal will be 180 feet wide at its mouth and will have a length of 1200 feet. From the mouth it will be gradually narrowed to 100 feet.

The Hudson River tunnel which is to connect Jersey City with New York, has extended under the river 3700 feet from the New Jersey side. It is announced that no attempt to drive a heading from the New York side will be made. The 2000 feet yet to be cut through will all be taken out from the New Jersey side. It is also stated that the excavation will be completed in about seven months.

TO Avoid Radiators in Rooms where direct radiation is desirable is one of the things all architects would be glad to do, and such avoidance would also be sure to meet with popular approval. In the majority of houses heated either by steam or hot water it is desirable that all floors above the first shall be heated by radiators on these floors, because this not only renders the heating apparatus less expensive in erection, but also requires much less fuel than in apparatus in which indirect radiation is wholly employed. An ample quantity of pure, fresh warm air for ventilating the whole of an ordinary dwelling may be introduced through the indirect radiators on the first floor, and by proper arrangements this air can be well distributed through the rooms on the higher floors, so that these as well as the lower rooms shall get their share. But "the hideous direct radiators," and the floor room they occupy, are objections to many so great as to impel them if their means are limited to forego heating by steam or hot water altogether, or, if their means are ample, to adopt the more expensive system of indirect heating. It has always seemed to the writer that it is possible to design and decorate direct radiators in such manner that there should be no valid objection to them on the score of appearance and, in fact, within a few years, some manufacturers have placed on the market radiators which are quite artistically designed; but they take up just as much floor room as the others. It has also seemed to the writer that it is nearly always practicable to provide recesses in walls or partitions in which extended surface radiators or even common box coils could be placed with a nicely finished register below for inflow and another higher up for outflow of air when circulated through the recess by heating; and, by also providing proper recesses in the walls for running riser pipes to these inclosed radiators, the removal of the radiators from the floor-space, and their concealment could be simultaneously effected. This is not suggested as being new (in recent years it has been done in a number of buildings), but as being practicable in more instances than it is usually thought to be by architects. A common objection to this mode of placing radiators is that the cooler air entering at the bottom flows as it is warmed out at a point too high for conveniently warming the feet. The writer suggests that this can be completely surmounted by bringing into the room a short section or loop of the steam pipe near the base-board or perhaps two or three short pipes made up with headers into a small flat horizontal coil in an inconspicuous part of the room with a small ornamental grating upon which the feet may rest close to, but not in actual contact with the pipes. This simple and cheap device has been tried and may be relied upon to give all needed foot-warming accommodation.

The Floors of Fire-Proof Buildings, according to the statement of a St. Louis architect, have the peculiarity that it is impossible to keep the floors level. He says:

"This applies to all buildings in which iron is used for supporting floors, but particularly to those in which steam is extensively applied to heating. The steam pipes running near the iron girders cause them to expand, and as the walls are always strong enough to resist the pressure, there is a forcing up of the iron. This causes irregular hills and valleys in the floor, although, of course, they are not very apparent."

He cites in support of this assertion examples of so-called fire-proof buildings in St. Louis, and seems thereby to make good his statements. It would be worth while perhaps to go a little further and ascertain in what degree irregular surfaces in the floors noticeable in many buildings not classed as fire-proof are due to the methods of heating employed in them.

Facts About Indiana Oolitic Limestone are given in the May issue of *Stone*. From the article published in this new and, we may add, well-edited and very interesting contemporary, we gather that the durability of this material is probably as great or greater than that of any other stone quarried on this continent. In chemical composition as well as in grain its uniformity is remarkable. It has no cleavage in one direction more than another, and when struck gives a clear, musical, metallic sound. It possesses great elasticity as compared with other stone, and to this is probably attributable its power to withstand the temperature changes so trying in our climate to building stones generally. The chemical purity of the stone is quite remarkable, being 97 per cent. pure lime carbonate. We quote an analysis made by the State Chemist of Georgia:

Carbonate of lime	96.04 per cent.
Carbonate of magnesia	0.72 "
Oxides of iron and alumina	1.06 "
Insoluble silicates	1.13 "
Chlorides of soda and potash	0.15 "
Water expelled at 212° F.	0.10 "
Combined water	0.80 "

The stone has in the quarry a cheese-like softness, but it hardens upon exposure. This softness renders it the cheapest stone to work anywhere known. A block 105 feet long, 7 feet thick and 6 feet wide taken from the Peerless quarry, near Bedford, from the top cut under the stripping and weighing 330.5 tons is cited in proof of the capabilities of this stone as regards getting blocks of any required size. The demand for this valuable stone is stated to be constantly increasing. We notice one important omission in the enumeration of the qualities of this stone, to wit: a statement of its fire-resisting quality as compared with other kinds of stone, a quality in which New England granite is notably deficient.

The New Carnegie Music Hall in New York City was formally opened in accordance with previous announcements on the evening of May 5th, by the commencement of the five days' music festival, which, under the direction of Mr. Walter Damrosch, was in advance sure to prove a notable musical event. The opening of this great and elegant temple of music was signalized by short addresses delivered by Mr. Morris Reno and by Bishop Potter. The latter, who has on one or two occasions when speaking upon secular topics indulged in remarks open to criticism, made on this occasion a rather derogatory allusion to the Scottish bag-pipes, evidently called forth by the consideration of Mr. Carnegie's Scotch nativity. Hardly in good taste, we think. The bag-pipe has an honorable place in Scottish history as having often excited high courage in the hearts of Scottish soldiers in the hour of battle; and it is admittedly the progenitor of the grand church organ, so intimately connected with the ritual and service of the English Church in which Bishop Potter has risen to the high office he ably fills. The general design of the large main hall in which this festival was held is extremely satisfactory. The architect, Mr. William B. Tuthill of New York, has reason to congratulate himself upon the success he has achieved in the always difficult treatment of acoustic principles in the design of large auditoriums. So far as we have heard, there has been no adverse criticism on this point, and, judging from personal observation, we can see no cause for any. The hall, whose seating capacity exceeds that of the Metropolitan Opera House in New York, was filled with ease by the voices of the soloists, and the effect of the chorus of 500 singers accompanied by the full orchestra was very grand. The harmonious treatment of the decorative colors —white, salmon and gold—was somewhat marred by the rather overpowering illumination of the 4000 electric lamps with which the hall is lighted. Mr. Carnegie is to be congratulated that he has found in Mr. Tuthill such an able and earnest co-

adjutor in carrying out his wishes. The great city of New York and the American public are to be congratulated also on the possession of a citizen like Mr. Carnegie, who knows not only how to create wealth, but how to employ it so that it not only gains for himself the most exalted pleasures, but confers lasting benefits upon the entire community. One such noble citizen, the late Mr. Charles Pratt, has gone from us since our last issue. It is fitting that he should be long remembered. Like Mr. Carnegie, he also knew how to create and wisely employ wealth, and his works live after him. Were the enormous wealth of this country wholly represented by such exemplars, the popular outcry against plutocracy would dwindle to a contemptible whine of envy, or be altogether extinguished.

The New Music Hall has cost the large sum of $1,250,000. The chief materials of which it is built are terra cotta, iron and steel, and the building is hence termed fire-proof, though in view of the fate which has overtaken so many "fire-proof" buildings, this term may probably be interpreted as meaning as resistant to fire in or outside of it as is possible in the construction of buildings comprising iron as a notable part of their structure. Great pains have been taken to secure good heating and ventilation; but the success of the appliances for these purposes must, for its determination, probably await test in colder weather than there has been in New York since the opening of the building. The main hall will comfortably seat 3000 people. The arched ceiling of this hall has been generally much admired. As we have intimated elsewhere the lighting of the hall appears to err on the side of excess, a fault easily remedied.

Hardware Specifications are asserted by the *Trefoil* (a small monthly published for gratuitous distribution by the Yale and Towne Manufacturing Co.) to be an anomaly in architectural practice. It is affirmed that the parts of specifications relating to builders' hardware are less specific than any other, and leaves the contractor to choose that which is the cheapest, only confining him perhaps to some particular manufacturer's list. As a remedy for this, arising from the fact that architects are not, and in the nature of things cannot be hardware specialists, the suggestion is made that any attempt at specifying the finer hardware for buildings be omitted and that as a substitute for such specification a simple statement be made that the locks and fine hardware shall be selected in consultation with, and placed as directed by the architect. Or the following form, as meeting the case fully, is proposed:

"HARDWARE: The hardware for all doors, windows, closets, cupboards, drawers, transoms and water-closets, as well as all cabinet hardware, to be furnished by the owner when reasonably required and to be applied in thoroughly first-class manner by the contractor, special care being taken to protect the finished work from injury or soiling. The contractor will also be required to furnished such information as may be necessary to enable the owner or his agents to supply the hardware in the manner above referred to in a satisfactory manner, and to give to the architect and owner due and sufficient notice as to the time when such hardware will be required. All other hardware to be supplied by the contractor."

Difficulty in Obtaining Competent Assistants in the office of the Government Supervising Architect at Washington has been experienced. It was claimed by rejected candidates and their friends that this was owing to the difficult character of the civil service examinations. In order to facilitate the obtaining of assistants a resolution was passed by the last Congress exempting applicants for such positions from civil service examination, but the difficulty in filling the positions yet remains. The reason is not that qualified men are lacking, but that those who are qualified cannot afford to accept the salaries paid by the Government, as they can do better to remain in the employ of private architects where even with no better pay they have opportunities for advancement they would not have in the Supervising Architect's office.

The Plan of a Building should begin with the roof. This is the dictum of an architect whom a daily New York paper declares to be an expert. Without deciding upon the soundness of this rather

broad generalization which would certainly not extend to a structure which has no roof, there are some other parts of his deliverance which may be read with profit. He asserts that the "purpose of the roof is not merely to keep out rain, but it should also protect from changes of weather, fire, etc. The ordinary roof meets none of these points. The slate cracks easily under either heat or cold, admitting rain, attracting heat, and inviting conflagration. Some of the very best roofs are over the oldest factories, with solid framed, matched boards, covered with limed mortar, upon which the shingles were laid. The ideal roof is nearly flat—an entirely flat roof will shed rain. The best way is to pitch the roof of industrial buildings toward the centre, with a pitch of only half an inch to a foot. This carries the water away through a channel not exposed to frost, and admits of much better advantages in the matter of light in the upper story."

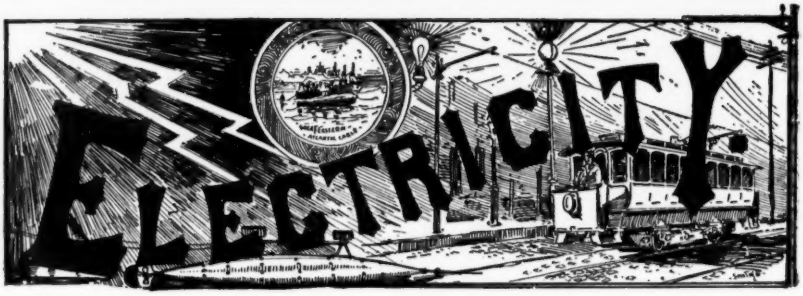
The Lion bridge, near Sangang, in China, extending 5¼ miles over an area of the Yellow Sea, and supported by 300 huge stone arches is named as the longest bridge in the world. The roadway is 70 feet above the water and is inclosed in an iron network. A marble lion 21 feet long rests on the crown of every pillar. The bridge was built at the command of the Emperor Kieng Long, who abdicated in 1796 on account of old age.

The Supervising Architect's Office at Washington should be abolished. The sooner the better, both for the interests of art and the public purse. Upon this subject the *American Architect* very forcibly remarks:

"As it has been demonstrated officially, over and over again, that the cost of the architectural work on the Government buildings, under the present system, is greater, in some instances very much greater, than if it were done by private architects, as it is everywhere else in the world, and according to the present accounts, the work is worse done, we should think it would occur to some one besides the architects, who knew it well enough, but do not like to be conspicuous in calling attention to it, that it is about time to put a stop to the practice. The fact is that the Supervising Architect's office has no reason for existing, and ought to have been abolished long ago. It is generally supposed to have been instituted in the corrupt period which followed the war, to serve under a thin veil of plausibility, as a political agency. Under the faithful and upright direction of the men who have administered it, the expectation that it could be used for such a purpose has been disappointed, and under the more wholesome conditions which now exist at Washington, there is no probability that it can ever be used as a means of corruption. Meanwhile, however, it pursues its ponderous way, grinding out its mediocre designs, and filling the country with public buildings which have not the slightest artistic interest, or even superior merit of arrangement, while if the ordinary practice of civilized countries had been followed for the past twenty years, we should by this time have had nearly every important town in the United States adorned with a masterpiece of the best work that American architects are capable of, and should, besides, have saved many million dollars."

There can be no doubt that this view is correct. The work of supervision should always be done by the designer of a building, and good designs for large public buildings can only be obtained by selection from designs of competing architects. No one architect will supply satisfactory plans for so large a number of buildings as the Government annually erects; and it also certain that one man cannot supervise properly the erection of so large a number of buildings situated widely distant from each other.

The Silver Maple, commonly called "soft maple," is asserted by *Garden and Forest* not to be a soft wooded tree. On the contrary its wood is hard and fine grained, and an excellent and valuable material for floors of houses and for furniture. It grows very rapidly, and even in unfavorable situations few trees will attain a greater height or a thicker stem in the first forty or fifty years of their existence. It is this rapidity of growth that has made the silver maple a favorite with people who are in a hurry to obtain immediate effects. It only reaches perfection as an ornamental tree tree on low, moist, sandy soils. On account of its rapid growth, however, the tree is often selected and planted without due regard to an appropriate soil, and disappointment follows, as the tree fails to attain its proper beauty.



ELECTRIC Traction by Storage Batteries has been given a trial in Philadelphia, with a system embodying several novel features, and the results obtained so far are highly satisfactory. The batteries and motor used have been designed by Messrs. J. B. Entz and Montgomery Waddell, of New York, who have arranged a complete storage battery car equipment which is now known as the Waddell-Entz system. This system, if it performs as well in actual practice, under all sorts of conditions as it has during the experimental trials, is destined to achieve considerable prominence, because of all methods of electric traction for street work that which makes use of storage batteries is the ideal one; each car is a unit by itself and no outdoor construction nor special track equipment are necessary. In a word, this system combines all the advantages of animal and electric traction. There are three special features in the Waddell-Entz system which distinguish it from other storage battery car equipments. An alkaline accumulator with plates of iron and copper is used instead of the usual form of acid accumulator with lead plates. The motor is of a new type, very light, running at a low speed and with single gearing, and the batteries and motor are so arranged that when running downhill the motor acts as a dynamo and partially recharges the accumulators. The battery is an improvement, or rather a development of the accumulator brought out some time ago in France by Desmazures; it consists of a plate of iron and one of copper (this latter specially prepared so as to have a very porous surface) immersed in a solution of potassium zincate. When the cells are being charged metallic zinc is deposited on the iron electrode and the copper is oxidized. On discharge the zinc is dissolved and the oxide of copper reduced, potassium zincate being formed. In adapting this type of cell to perform heavy work several difficulties, both mechanical and electrical, were met with, but they have all been satisfactorily overcome. For one car 100 cells of battery are used, the cells being placed, in the usual manner, under the seats. The 100 cells give from 75 to 80 volts and can deliver as much as 300 ampères of current without evolution of gas or serious heating. One great advantage is the gain as regards weight. The weight of the complete set of cells is only about 60 per cent. of that of lead accumulators of equal capacity. The motor, also, is very light and is quite a new departure in car motors. The armature is a gramme ring and the field magnets are inclosed by it, the armature and brush holders being supported by a non-magnetic frame. The armature makes about 450 revolutions per minute when the car is travelling at the rate of 10 miles an hour. The trials in Philadelphia have been made on a track three miles long, and the results have been so satisfactory in all respects that advocates of storage battery traction feel highly encouraged by the prospect of the practical introduction of a more efficient system than those previously tried.

Electricity In the Production of Aluminium was treated of by Mr. Alexander S. Brown at the April meeting of the American Institute of Electrical Engineers. Mr. Brown reviewed in an interesting manner the history of the commercial production of aluminium. This dates from about 1854, when Deville, a French chemist, turned his attention to the reduction of aluminium by

means of sodium. Works were finally established at Salindres, and for many years all the pure aluminium consumed in the world was produced there. Up to 1886 the annual production was less than 10,000 lbs., of which the greater part was made in France. In 1887 aluminium sold at $5 per pound. To-day it sells at $1 per pound. In the past few years electrical processes for reducing aluminium have been developed and are now used almost exclusively, the cost of production being greatly reduced. In April, 1889, Mr. Charles M. Hall, of Oberlin, Ohio, secured patents for an electrical process of reducing pure aluminium. The Hall patents are controlled by the Pittsburgh Reduction Co., which has a plant capable of producing about 300 lbs. of metal daily. Early this year the price was reduced to $1 per pound for commercially pure aluminium, of a guaranteed purity of ninety-seven per cent. The Cowles and Héroult processes of electrically reducing aluminium, which are extensively used in this country and abroad were also described. One striking feature of these electro-metallurgical processes is the enormous size of the dynamos which are employed to furnish the current. At the works of the Allegemeinen Electricitats, at Schaffhausen on the Rhine, dynamos of 600 electrical horse power, weighing over fifty tons each, are used. At the aluminium works at Boonton, N. J., where the Héroult process is used, the dynamo weighs nearly 20 tons and at a speed of 220 revolutions per minute generates a current of 35 volts and 35,000 ampéres. This machine was bullt at the famous Oerlikon works in Switzerland. The conductors used to carry the current are square copper bars of one inch cross section. Pure aluminium has a beautiful white color slightly tinged with blue. It is fibrous in structure and bends considerably before breaking. If the metal contains more than one per cent. of impurity it becomes brittle and has a crystalline structure. It melts at a slightly lower temperature than silver, and has a specific gravity of 2.6. In the course of the discussion it was pointed out by Prof. Crocker that the properties and probable applications of aluminium had been very greatly exaggerated. The pure metal has very few advantages owing to its softness and low tensile strength, and it is readily attacked by alkalies; these qualities preclude its use for many purposes. Electrically it has no special advantage, as its conductivity is about half that of copper for equal volume. Its most important application is in the form of alloys. The alloy with silver (containing from one to five per cent. of silver) is a metal that takes a high and lasting polish, has a brilliant color and is light and strong. Aluminium bronze, containing about ninety per cent. of copper, has a very high tensile strength and is remarkably free from tarnishing; its specific gravity, however, is higher than that of iron. It is evident that the chief field of application for aluminium lies in the direction of the alloys. The pure metal itself is not a promising subject, and even if it were, the fact that a very small percentage of impurity is sufficient to render it totally unlike itself is not encouraging. The chief difficulty which prevents the rapid adoption of the aluminium alloys in the industrial arts is that the manufacturers have not yet learned how to handle them, when they do learn this—and there is plenty to learn—the production of aluminium will no doubt receive a considerable impetus.

The Protection of Buildings from Lightning was discussed by Mr. N. D. C. Hodges at the same meeting of the Institute. Mr. Hodges is not a believer in the ordinary lightning rod which has done duty for so many years, but advances in its place the theory that a conductor, or a number of conductors, should be provided on which the lightning discharge could vent its fury; the conductors would be dissipated and no further damage would be done to the building thus protected. In support of this theory Mr. Hodges cites a number of instances of buildings being struck by lightning, and where there was any wire or metal work (even so light as gilt paper and decorations) the wire or metal were entirely dissipated by the discharge and no damage was done in their immediate neighborhood, while serious damage was

done both above and below the parts protected by the conductors which were thus dissipated by the discharge. The form of protector advocated by Mr. Hodges is a light copper ribbon weighing about 75 feet to the pound; the ribbon is to be cut in sections two feet long and tacked to the building from ridge-pole to foundation, the joints being made of low conductivity by the insertion of insulating washers. No collecting points are used and no connection with the earth. If lightning strikes the building the conductors will be destroyed by the charge, but nothing else would be harmed. Mr. Hodges says that he has thus far found no case on record where the dissipation of such a conductor has failed to protect the building, but he does not cite any instance of a building equipped under his system having actually been struck by lightning and protected from damage by the dissipation of the two-foot lengths of copper tape. This plan of protection is as far removed from the standard lightning rod as it is from Dr. Hodges' metallic cage, and it will be interesting to observe the practical results of its adoption.

A Notable Feat in Long Distance Telephony, interesting to record, is reported from London. Numerous experiments have been made with the London-Paris telephone line and one of these was to connect at Paris with the line already in operation between Paris and Marseilles. Direct telephonic communication was then maintained between London and Marseilles, a distance of over 700 miles. The experiment was perfectly successful from a scientific point of view, although the speaking was of course not so good as between London and Paris. This result very clearly shows the possibilities of long distance telephony, and as improvements in apparatus and line construction continue to be made, still more far-reaching results may be expected in the course of the next few years.

Electrical Communication with Light-houses and Light-ships is the question of the hour in electrical circles in England.

It is undoubtedly a question of vital importance as many of the lives which are lost every year on dangerous coasts would be saved if the rescuing parties received prompt warning of impending disasters together with directions as to the location of the wreck. This information could in many cases be given by those in charge of light-houses and light-ships if they had telegraphic or telephonic communication with the mainland. Numerous experiments have been made in connecting these posts of warning with the shore by means of submarine cables, but great difficulties have to be encountered, especially in the case of light-ships, because as their position is constantly changing with the wind and tide the connection of the cable to the vessel offers mechanical problems not easily overcome. It has been proposed to establish communication with these vessels without directly connecting the cable to the light-ship, by employing the system used in signalling across rivers in India with uninsulated conductors, but this is hardly a satisfactory solution. The whole question of coast communications is now being actively agitated in England, with a view to inducing Parliament to vote the funds necessary for the construction of a complete chain of telegraph communication between the coast guard stations and the existing telegraph system, and also for the establishment of submarine cables between the most exposed light-houses and light-ships and the shore. It is felt that if the funds are forthcoming the electrical engineers will be fully able to carry out the work.

The Electro-Plater's Handbook, by G. E. Bonney, is the latest addition to the growing series of practical handbooks to the production of which the makers of electrical literature have been turning their attention for the last few years. The present work is a useful little guide to place in the hands of any man occupied in electroplating in a small way. It is not written with any pretence to literary style but is plain and practical throughout, and the influence of workshop experience is apparent in almost every page. The book is well arranged and fairly well illustrated. Less space might have been devoted to

dynamos and more to the practical operations of electro-plating, but in this latter respect those who turn to the book will not have very much cause for complaint as there is a pretty liberal allowance of working directions on the treatment of all sorts of articles with all sorts of metals. The book is published by the D. Van Nostrand Co., 23 Murray Street, New York.

The Westinghouse Electric and Manufacturing Company has, it is generally reported, tided over the financial difficulties which at one time threatened its existence. A syndicate of bankers has been formed to undertake the reorganization of the company, and a plan has been arranged, which, it is believed will be favorably received by the stockholders. The business of the company has been continued without interruption, and although with a lesser volume than for the same period last year, the net results have been better. The orders in hand and those being received are equal to the capacity of the works, and it is expected that the works of the company will soon be again in full operation. A reduction has been effected in expenses and a more conservative business policy has been adopted, so that the affairs of the company have been steadily improving since the first of January.

Electric Tramways for Mills and Factories were referred to in a preceding paragraph, and the practical application of electrical transmission of power to the transportation of raw and manufactured material is one in which manufacturers and mine owners will take considerable interest. A number of these plants have lately been installed by the Thomson-Houston Company, and others are in course of installation. At the mills of the Nashua Manufacturing Company, at Nashua, N. H., two separate tramways have been equipped; one of these is a wide gauge of four feet eight and a half inches, the other a narrow gauge of thirty-six inches. The narrow gauge road is used for the transportation of cloth from the mills to the cloth room, a distance of 1500 feet. The car is provided with one 3 horse power Thomson-Houston motor and can handle a load of 3000 pounds at a speed of five miles per hour. The car for the wide gauge road is equipped with two 3 horse power motors and has a hauling capacity of two tons and a half at a speed of six miles an hour. The single trolley system is used, the return circuit being completed through the rails. The current is supplied by a 220 volt generator. Where the electric tramway is used inside the mills the double trolley system is employed, to avoid all danger of fire through sparking between the car wheels and the rails.

A New Alternating Current Motor has just been brought out by Lieut. Jarvis Patten, who has devoted much time to the study of the peculiarities of the alternating current and its availability for motor work. Lieutenant Patten's new motor is really a continuous current machine. The armature shaft carries a revolving switch with alternate segments against which two pairs of brushes bear; one pair is connected to the transformer and the other to the armature and field magnets of the motor. When current is turned on the motor starts and as soon as it acquires sufficient speed, the revolving switch acts to rectify the alternations of the current, the result being that a pulsating continuous current is supplied to the motor. This extremely ingenious arrangement is found to answer well in practice. When the armature reaches its proper speed, so that the revolving switch completely rectifies the alternating current, the machine is capable of giving its greatest output and the tendency is for the speed to remain constant up to the maximum load: there are no reversals of field or armature polarity, little sparking, and no appreciable heating. A motor of this type, weighing less than 100 pounds, is found to develop considerably more than one horse power without bad sparking or heating when connected to the secondary circuit of a converter. There is a large field awaiting the commercially successful alternate current motor, and this new type promises well as far as the experience of the inventor has yet carried him.

The Electrical Section of the World's Fair is doomed to be deprived of much of the importance it ought to have, and which electrical men throughout the country

wish to give it, if the directors of the exhibition persist in their ill-advised policy of allowing insufficient space for the electrical exhibit. Their idea is to place part of the electrical exhibit in one building and to distribute the rest among other departments according to the applications of the various electrical machines and apparatus. The directors are also opposed to the construction of a power house within the exhibition grounds, although this is rightly held to be an absolute necessity, as unless they could be shown in actual operation, many of the electrical appliances to be exhibited might just as well not be sent to the exhibition at all. The matter is still under discussion at Chicago, and those who have the interests of the electrical fraternity in charge are working their hardest to induce the directors to afford every facility for making the electrical exhibit the colossal success that it ought to be. A step in the right direction has been made by confining the electrical committee to its proper sphere. The committee was at first known as the "Committee on Machinery and Electrical Appliances," but by a recent amendment to the by-laws this was changed to "Committee on Electricity, Electrical and Pneumatic Appliances." This committee (consisting of five members) "shall have jurisdiction over all matters pertaining to electricity, electrical and pneumatic appliances, and all plants connected therewith." The machinery was placed in charge of the committee on manufactures. Pneumatic appliances were placed in the electrical committee's charge, because the directors thought that devices of this character were frequently operated in connection with electricity. Our contemporary, the *Western Electrician*, is doing excellent service in giving the fullest publicity to all doings in connection with the electrical department of the Fair.

A Chart of Standard Electrical Diagrams and Symbols, compiled by Prof. Francis B. Crocker, of the Electrical Engineering Department of Columbia College, was published in the issue for May 13 of the *Electrical Engineer*. This chart contains the most important and standard electrical diagrams and symbols collected in compact form for easy reference. It may not be perfectly complete, but the idea has been to represent the most typical of the various kinds of apparatus, systems, and facts which are to be found in electrical engineering, beginning with the simplest and passing to the more complicated. The chart is also intended as a basis for a course of electrical draughting in technical schools and offices, there being no rules, guides or models to follow at the present time. It is an exceedingly neat and well executed piece of work, and should undoubtedly find a place in the office of every engineer.

Electricity in Mining Operations was enlarged on by Mr. H. Ward Leonard in a paper read before the Association of Mining Engineers of the Province of Quebec. Mr. Leonard laid special stress on the importance of the introduction of the electric percussion drill. "Until recently, when a mine owner asked if we could transmit his power, light his mine and operate his pumps, hoists, tramways and mills, we could confidently reply 'yes.' But when he asked if we could operate or replace his air drills, we were obliged to say 'not yet.'" Now, however, the electric percussion drill has been perfected and it offers many advantages over drills operated by any other power. It enables the rate of drilling to be increased by increasing the number of blows per minute. With the air or steam drill the limit is soon reached for various reasons; with the electric drill there is no limit to the rate of striking, unless it is in the magnetizating and de-magnetizating of iron, which is already done in daily commercial practice at the rate of 10,000 times per minute. For diamond drills the electric machine has many points of superiority over the steam diamond drill. It has no reciprocating parts and works smoothly and without any jar, the speed being absolutely constant under any conditions of load up to full load. The weight of the electric diamond drill is, for the same power, much less than that of the steam drill, it occupies much less space, and can be placed entirely in a direct line with the hole.

The Utilization of Water Power by Electricity was referred to at length last month. As an instance of the enormous strides now being made in this direction, a brief description of the plant recently completed by the Edison Company at Spokane Falls will be found interesting. Engineers generally take great interest in this station, as it is a practical and eminently successful demonstration of the advantages to be derived from the utilization of water power for electrical work. The hydraulic equipment has been designed in the most thorough manner, and in magnitude it has no rival in any other part of the United States. The hydraulic machinery is all arranged on the first floor, and the dynamos on the floor above. There are twelve wheel cases, each of which contains a pair of horizontal Victor turbines of the Stilwell and Bierce manufacture. The entire power of the station is 2700 horse power, and this aggregate is divided between twelve separate machines, each independent of all the others; any pair of wheels can be shut down, a set of six pairs of wheels can be shut down by closing one of the penstocks or the entire plant can be shut down by closing both penstocks. There are now eight pairs of wheels equipped and in operation. Two pairs drive twelve 50-light Thomson-Houston arc machines, and the other six, which are smaller wheels, drive twelve No. 20 Edison incandescent dynamos. At the present time 1500 horse power is used for the generation of electricity in the station, but this large figure is constantly being increased, as additional demand is made for light and power. Nearly 500 arc and 8500 incandescent lights are in operation, and motors of all sizes aggregating about 250 horse power. A pair of 17½ inch wheels is now being equipped for driving two 80-Kilowatt Edison generators for street railway work. The supply of power is absolutely uninterrupted day and night all the year round. Some of the incandescent generators have been running continuously for fifteen months, supplying current to motors for elevators, printing presses, etc. The advantage of water power over steam is very noticeable in the station; there is no handling of coal, no grease, dirt, ashes, and no excessive heat. The turbines run so smoothly that there is very little noise or vibration, and they can all be properly looked after by one attendant. As one may well understand there is plenty of electric light in Spokane, and electric power is everywhere; very cheap rates are made, and the motor service has become very popular. All the printing presses and most of the elevators in the city are run by electric motors, and other machinery from saw mills down to clocks, everything conceivable is driven by the falls by the aid of turbine, dynamo and motor.

Electricity in Warfare is destined to become a fruitful topic of discussion in the near future. A writer in the *Electrical Review* points out that the recent blowing up of a Chilian man-of-war by a torpedo is a hint of the part which electricity will surely play in future wars. Napoleon said that Providence is always on the side of the heaviest artillery. Hereafter Providence will be found on the side of the greatest electricians. Although so much has been written about electricity in warfare, its applications are so numerous and wonderful that some of them have not even been thought of. At present electricity is used for firing and manipulating guns, discharging and propelling torpedoes, for signalling, lighting and other minor uses. But by the use of electricity there is a possibility that gunpowder may be dispensed with. Imagine a modern battle-ship armed with great breech-loading rifles and immense dynamos. Instead of a cartridge containing gunpowder, there would be one partially charged with water from which two metal conductors would be led to the dynamo. Now to fire the gun it is only necessary to turn on the current and decompose the water, thus producing an explosive mixture of hydrogen and oxygen, which, ignited by an electric spark, would cause a violent explosion behind the projectile.

Of course, to be efficient, the electrolysis of the water must be extremely rapid; and means for rapidly repeating it while holding the separated gases in a compressed state, must also be provided.

THE Proposed New Mining Law in Canada is not generally received with favor. In the *Engineering and Mining Journal* (New York), it has been adversely criticised by probably the ablest writer now contributing to American mining literature. The Canadian press seems variously inclined toward it, but we judge the tone to be on the whole adverse. The *Marine Review* (Cleveland, Ohio), says "the provinces of Quebec and Ontario are greatly disturbed by the proposed acts, which it is declared will be a death-blow to mining business especially if the royalty features are carried." It adds, that "the mining men of Quebec have petitioned the Governor-General in council praying for the disallowance of the act. The bill for Ontario has passed its second reading but was vigorously attacked in committee and, as finally amended, differs materially from the original. It now provides that the price of mining lands in the districts of Algoma, Thunder Bay, Rainy River, and that part of the Nipissing district lying north of the French River, Lake Nipissing and the Mattawa River, where the same are within 12 miles of a railway, shall be $4.50 per acre; other mining lands to be $3 per acre; for mining lands lying south of the aforesaid lakes and rivers, within 12 miles of any railway, the price will be $3 per acre; when situated elsewhere $2 per acre. To insure speedy development the royalty shall not be imposed upon silver or copper ores mined until seven years from the date of the patent or lease, and for nickel ore four years are allowed before the royalty shall be imposed."

The Loss of Carbon from Pig Iron from Rusting having recently engaged the attention of Mr. J. G. Donald, while examining samples of pig, he was led to an investigation having for its object the quantitative determination of such loss. He writes to the *Chemical News* that while he was engaged in the determination of the graphite and carbon in two samples of pig, the drillings weighed off for treatment with copper and ammonium chloride were brushed into beakers which were wet, having been rinsed with distilled water. At this point, and before the solvent had been added, he was called away. On returning to the work, after the lapse of nearly a week, the drillings in the beakers were found to be much rusted. The idea occurred to him that it would be interesting to learn to what extent there had been loss of carbon through the rusting of the drillings. To this end a determination of carbon in the rusted portions as well as in the original samples was made with the following results for total carbon: Rusted drillings No. 1, 1.941%; No. 2, 1.332%. Original sample No. 1, 2.282%; No. 2, 2.132%. The combined carbon in each of the samples was found to be as follows: No. 1, 0.378%; No. 2, 0.336%. It will thus be seen that in the case of No. 2 the rusting has caused a disappearance of a portion of the graphite. No. 2 was much finer than No. 1, and to this fact is doubtless due, in part at least, the greater loss of carbon in No. 2.

Coal Mining in Michigan is now a paying industry at three points, viz.: Jackson, Owasso and Sebewaing. The *Colliery Engineer* thinks the latter promises to become the most important, although the largest establishment at present is that of the Standard Mining Company, located one mile from Jackson. The coal bed at this point varies from three to four feet in thickness, while the Sebewaing bed will average over four feet in thickness. The

quality of the Sebewaing coal is said, too, to be much better than the product of the Jackson County mines. The coal field of Michigan is detached from that of any other State. Its area is embraced principally by the counties of Saginaw, Shiawassee, Clinton, Ionia, Montcalm, Gratiot, Isabella, and Midland. Large areas also of Huron, Tuscola, Genesee, Ingham, Eaton, and Bay counties are underlaid by the coal formation, making in all fourteen counties, in addition to small portions of Livingston and Jackson counties, and probably several counties to the north, which are also underlaid by the coal formation.

The Magnetic Separation of Iron Ores is attracting increased attention, and is discussed (mainly with approval of its great promise) very fully in technical journals specially devoted to mining and metallurgy, and also in those which include these departments as part of the general field of engineering which to a greater or less extent is covered by them. Among the foremost of these is *Engineering* (London), in which we find the clearest statement of the conditions to be met, and the difficulties to be overcome, that we have yet seen, and a description of an extremely ingenious mechanism, whereby these have been satisfactorily surmounted. From this article the following is condensed.

Even if only a part of the rock is eliminated, there is a substantial gain, particularly in cases where the ore has to be transported long distances from the mine to the blast furnace. But if the gangue contain phosphorus or sulphur, so long as any appreciable amount of it remains, the iron made from the ore is unfitted for use in the Bessemer process, and sells at a lower price than it would if it had been freed from these impurities. Inventors have therefore striven to produce a separator which would remove the rock so effectually that not more than .05 per cent. of phosphorus should remain, even when the iron is associated with a gangue of phosphate of lime. The difficulty was, that immediately the pulverized ore was magnetized all the particles clung together, entangling between them fragments of rock. Various means were tried by vibration and alternate magnetization, and demagnetization to permit the rocky particles to get away from the embrace of the metal, but when particles formed partly of iron and partly of rock were attracted by the magnet they remained with the metal. In the Monarch magnetic ore separator, a very ingenious method has been devised of freeing the rocky particles, and of discriminating between those that are entirely metallic, and partly metallic and partly earthy. The crushed ore is fed on to the surface of a rotating paper drum. Within this drum, and occupying less than half its circumference, is a multipolar magnet, having twelve poles alternately north and south. Immediately the metallic particles touch the drum they become polarized, and hang on by one end. In passing from the first pole to the second of the stationary magnet the opposite pole of each particle is attracted, while that hitherto attracted becomes repelled. Consequently the fragment turns end for end, and in so doing any rock clinging to it has the chance to escape downwards under the action of gravity. This effect is repeated some twelve times. After passing half way round one drum the ore is delivered on to a second, running at a higher speed, and here centrifugal force aids the separation. The same process of turning over the fragments is repeated, and should any of them happen to be partly of rock and partly of iron they are sure to be thrown off and eliminated. The final product is almost entirely of iron, the phosphorus being reduced to .05 per cent.

Magnetic Ore Separation is making considerable progress. The *Iron Age* gives, in a recent editorial, an interesting summary of this progress, making therein a statement of a curious fact unknown to many, "that more than a generation since magnetic separation was experimented with in the district which is now foremost in the work, and which is sure to be greatly benefitted by it." Messrs. Witherbee Sherman & Co., of Port Henry, N. Y., are "carrying through a series of tests at their mines at Mineville, N. Y., which are destined to be of the greatest importance, not only to them in their great enterprises, but also to the Eastern iron trade generally." The experiment is to be thoroughly conducted and exhaustive, and is in charge of Mr. John Birkenbine, of Philadelphia. The article quoted states also that "magnetic separation is now being introduced or experimented with at a number of points in the belt of magnetite deposits which extends southward from the Ad-

irondacks through New Jersey and eastern Pennsylvania. Excellent work is being done at the Cheever mines at Croton, N. Y. A mill of considerable capacity is running at the Benson mines, Little River, N. Y. At the Ogden mines, near Dover, N. J., the Edison machine has just been started in an extensive plant, under adverse conditions. The Conkling machine is being used at the Tilly Foster mine, near Brewsters, and has been adopted to treat the tailings of the Chateaugay mill near Plattsburgh, N. Y. At R. Heckscher & Co.'s Weldon mines, in New Jersey, the machine of a Chicago inventor is being experimented with. Enough has been done thus far to conclusively settle at least one point, and that is that it is possible to make available profitably ore thus far considered too lean to be marketable."

The Enormous Coal Deposits of West Virginia, when considered in connection with the Duke of Marlborough's prediction as given in his article on "American Railroads and their Management," published in this issue of THE ENGINEERING MAGAZINE, are a subject of profound interest. Very few people except students and professors of mineralogy and geology, some alert capitalists and residents of West Virginia are aware of the great extent of these coal fields. The generally well-informed reading public beyond has merely the vague knowledge that there is coal in West Virginia, but the extent and prospective value of these fields are yet to be widely appreciated. As a help toward giving these facts greater publicity, we quote from the *Manufacturers Record* (Baltimore) a part of an interview held with Major E. W. S. Moore, Secretary and Treasurer of the West Virginia Central Railway. In reply to a question "Has West Virginia coal?" he answers:

"Millions and millions of tons of it; enough, if all the competitive regions were to shut down, to supply the world for years to come, and of the very best quality at that. Professor Pumpelly, the geologist of ability and wide reputation, made a personal examination of what we call our Upper Potomac field, and says: 'I should put at the minimum figure of 2,000,000,000 tons the amount of coal in beds of workable thickness in the Upper Potomac and Stony River Basin.' In the Elk Garden region, in the 14-foot or 'Big Vein' and the smaller veins, it is estimated there are 100,000,000 tons of workable coal. Then we open up the 'Roaring Creek Field,' in which Prof. I. C. White, State geologist for West Virginia, reports there are fully 100,000,000 tons of merchantable coal of a splendid quality for cooking purposes. The Big Vein coal of the Elk Garden region is known all over the country as equal to the best steam and smithing coals in the market, and commands a ready sale at top prices. The Upper Potomac coal is also largely used for steam purposes, but is especially adapted for blacksmithing and coke, being one of the purest coals mined anywhere."

The Coal and Iron Ore Production of Great Britain for 1890, was, according to a government report, of coal, 181,614,288 tons, and of ore, 8,417,476 tons. Of other minerals 4,874,123 tons were taken out, which total includes the output of fire-clay and oil-bearing shales.

The Edison Separator is, according to current report, being energetically pushed by those interested in its development. It is stated that these promoters have leased a number of now idle iron mines in Pennsylvania, New York and New Jersey, presumably on the supposition that by the use of the separator these properties can be made remunerative.

A Mining Capital of Five Millions is involved in the proposed consolidation of the Cleveland Iron Mining Company, and the Iron Cliffs Company, the two largest mining companies of the Lake Superior District, arrangements for which consolidation are reported to be completed. These two companies produced in 1890 no less than 556,000 tons of ore.

A Large Saltpetre Deposit is reported to have been found in Goshen Cañon, Juab Co., Utah. The saltpetre is found in incrustations on the walls of large caves in limestone mountains about 15 miles southwest of Eureka.

Compressed Air Production, is treated in a lecture by Mr. William L. Saunders, C. E. M. Am. Soc. C. E., reprinted in pamphlet form by the *Engineering News* Publishing Company *Tribune* Building, New York. The essay comprises rules, tables and illustrations relating to the theory,

practice of air-compression and compressed air machinery, making a comparison of the best practice in Europe and America. The lecture was originally delivered at Sibley College, Cornell University. So far as could be expected in the limits imposed by a lecture the subject is comprehensively treated, and it presents a very fair exhibit of the "present state of the art," to quote a familiar phrase in patent office practice.

The Harvey process Nickel Steel Armor Plate rolled by Carnegie, Phipps & Co., and tested at Annapolis has proved wonderfully resistant to the penetrative power of shot at very high velocity, as well as remarkably free from the tendency to crack, as compared with the all steel plate, and the nickel and steel plate subjected to the same test. Twenty-six shots striking at a velocity of 1800 feet per second as fired from a 6-lb. Hotchkiss rapid firing gun, were received by the nickel steel plate, yet it was not pierced and was only very slightly cracked; while the all steel plate was both perforated and shattered, and the nickel and steel plate was perforated.

A New Boring Apparatus for Mines is described in the *Practical Engineer*, England. It has been invented and designed by Mr. J. Cowey, a mining engineer of Sunderland. With it holes can be bored in coal or other minerals without danger to life arising from the sudden escape of gas or water from spaces wherein they have been confined, as old workings, etc. In such an emergency the only resource has hitherto been to withdraw the tool and plug the hole, a difficult and often impracticable task. With Mr. Cowey's invention the hole in the coal or other mineral is made gas and water-tight from the first operation of the boring tool, which works within a tube casing first inserted in a hole bored 2 ft. or 3 ft. from the "face" to receive it, and made gas and water-tight both at the inner end and also against the face by packing, so that even should the casing tube be damaged between these points no gas or water will issue at the "face." The outer end of the casing tube is secured to a timber frame as a fulcrum, and beyond has bolted to it a sleeve nut tapped to receive the screwed length of the feed screw of the boring bar, which is operated by manual or other power. At some convenient portion of the casing tube outside of the "face" a downward branch is provided, which is closed by a straight through valve, which, being opened, allows the *debris* from the boring tool to fall downward to the floor of the seam. A gauge is also provided to indicate the presence and pressure of gas or water if any be met with. The apparatus having been fixed, the casing tube is tested by a pump attached to the outer end, with a pressure considerably above what would be due to any possible head of water likely to be met with. The test pipe is now removed, and the sleeve nut bolted to the outer end of the tube, and the required lengths of boring tool rods are inserted to reach the inner end of the tube, the screwed feed-rod entering the outer end of the sleeve nut. Boring now goes on until the length of screw on rod is through the nut, which is then disconnected, the screwed feed-rod drawn out, and another length of boring rod inserted, when the nut is again replaced, and the further boring proceeds, and so continues until either the total desired extent of the bore-hole is reached, or until the boring tool "holes" into old workings or spaces in which gas or water is confined, and the presence of which is first indicated on the gauge.

The Ores of Virginia was the subject of an extremely interesting and instructive paper read at a meeting of the Ohio Institute of Mining Engineers, by Mr. J. A. Ede, M. E. Mr. Ede said that the ores of Virginia, like the other features of its geology, stagger one when he tries to speak of them. Inquiring of a gentleman at Glasgow what minerals he had on his ground, Mr. Ede received in reply the following list of ores and minerals found in the Blue Ridge: "Allanite, carrying cerium and lanthanite, potter's clay, brown stone, tireon, or hyacinth, lead, silver, iron pyrites, copper pyrites, mispickle, sulphur, brick clay, soapstone, sandstone, marble, clay, slate, silica, corundum, crystallized quartz, mica, asbestos, talcose slate, molybdenite, dye stone, limestone, hydraulic

lime, fire-clay, magnetic iron, apatite, black oxide of copper, and red or erubisite, hematite iron, limonite iron, tin ores (abundant), stream tin, gold, dufrenite, graphite, kaolin, zinc ore, manganese, granite, platinum, and diamonds." Mr. Ede says that of the list given iron is the most important thus far. He thinks it premature to speculate upon what the mines of silver, gold, lead, tin and sulphur may yet develop, though he admits that some of them have promise.

The Tennessee Coal, Iron and Railroad Company refused an offer from English capitalists of $2,500,000 for the Tennessee part of their property. Whereupon the *Manufacturer's Record* remarks, that "When $2,500,000 of good English money will not tempt owners to sell, it is pretty conclusive evidence that they are not anxious to dispose of the property. Moreover, the stockholders who succeeded in defeating the attempt to sell are Southern people who have been the longest identified with the property, and who more fully realize its value than the Northern stockholders, who probably have only a faint conception of the intrinsic value of good Southern iron properties."

The Proposed Anthracite Mine Law, which has been reported to the Senate of the State of Pennsylvania by the Senate Committee on Mines and Mining, though on the whole approved as a good law by engineers and owners, and the *Colliery Engineer*, which probably represents the coal mining interests of the State as much or more than any other paper, has in it one feature severely criticised as increasing the already existing dangers in the use of high explosives. The journal quoted says the law "requires that all powder or other explosives must be carried into the mine at the expense of the operator. This means, if made law, that large quantities of explosives are to be taken into the mines in one trip, instead of small quantities, as is now the case when the miner takes his own supply. The cost of delivery will be trifling, but the danger of such a system will be great. Fifty or one hundred kegs of powder transported in mine cars run great risk of being exploded from a number of causes. A spark may be blown from the driver's lamp, or from the lamps of men standing or walking along the gangway, into the car containing the powder, and if exploded in a mass the probabilities are that the mine will be destroyed, and every person in it will be killed. The present arrangement of each miner carrying his own powder, or other explosive, is infinitely safer. The amount he carries is comparatively small, and he is able to keep it constantly safe, because of its small bulk and the fact that he has it under his arm, where it cannot be reached by a spark, except by design, or the most criminal carelessness."

An Important Boring, as likely to furnish valuable data to mineralogical and geological science is now in progress near Wheeling, West Va. The Wheeling Development Company have carried this boring, which is eight inches in diameter, to a depth of 4100 feet, in search of what they could find either of oil or gas. It is said that in its progress they have cut through several veins of coal, gold bearing quartz, iron and other minerals. It is now stated that after a depth of one mile is reached, the work will be continued by the U. S. Geological Survey, and that the boring will then be continued to as great a depth as possible with systematic records of temperatures, magnetic conditions and any important discoveries that may be made.

The Magnitude of the Virginia Ore Deposits, is indicated in the following abstract from the address of Mr. J. A. Ede, alluded to in a preceding paragraph. Of one seam of which an estimate was made over an area of about five miles long, by such authorities as Prof. Proctor, Mr. R. Moore, an English expert, who represented the English capital acquired by the Rockbridge Company through the influence of Hon. Col. Anderson and others, the latter gentleman states: "I think at a low estimate 8,000,000 tons of ironstone may be got from the seam; from Glenwood and from Echol, 1,000,000 tons." Prof. Proctor states: "I feel assured that there is enough of ore of excellent quality to be won at a small cost to supply a large iron industry for many years.

ROLLED Hollow Stay Bolts made of Tennessee bloom charcoal iron by an ingenious method are now undergoing a trial on several American railroads. The hole or hollow which extends through each of these bolts is ⅛″ diameter. Their strength is so far found to be ample. The object of the longitudinal hole is to indicate fracture (should this happen) by the visible escape of water or steam. The method of making these bolts will interest mechanics. Two bars each of a similar concavo-convex cross-section and with parallel marginal faces are wired together face to face, then raised to a welding heat, and welded together by passing them through a pair of rolls which not only welds but reduces the bars to a hollow cylinder and, as the welded cylinder leaves the rolls, a mandrel is inserted. The cylinder then passes to a second pair of rolls and by slightly cooling contracts upon the mandrel. In passing through the second pair of rolls the mandrel is withdrawn and slag and cinder removed from the hole, which completes the process. The tubes are about 6′ long. The hole varies from ⅜″ diameter for ⅞ bolts, to ¾″ diameter for 1½″ bolts.

Enormous belts, two in number, each 72″ wide and 154′ in length, made of double leather cemented together without rivets or pegs, form part of an order recently filled for the St. Louis and Suburban Railroad Company by the Schultz Belting Company of St. Louis, Mo. The railroad company also included in their order 700 feet of 16″ belting. The two large belts running upon pulleys of proper size are, at the very low speed of 1000 feet per minute, capable of easily and safely transmitting over 1700 h. p.

Hoisting Heavy Iron Doors is accomplished at the works of the Burden Iron Co., Troy, N. Y., by means of Weston triple chain blocks, this method having been preferred after full consideration of the older system of counterweights and pulleys. The doors are easily raised and held at any desired point without the use of any other appliances; while the cost of the heavy counterweights is saved. The saving will be seen to be a considerable item when it is added that there are no less than 110 of these doors in daily operation.

A Cold Saw, which on account of its great efficiency has begun to attract more than ordinary attention, has been designed by Mr. Potter, General Manager of the Homestead mills of Carnegie Brothers & Co. The saw is described as simply a slow running circular saw of hard tempered steel, thicker at the perimeter than at the arbor, cutting at the rate of one inch per minute. This is rather a vague statement of cutting-rate, as the thickness of the metal cut is requisite in determining the efficiency of the saw. The saw moves towards the material to be cut, the latter being held in a fixed position. The feed of the saw is effected by worm gearing operated by hand. The principal element in the effectiveness of this saw, the main features of which are not new, is running it in a lubricating tank containing an emulsion of

lard oil in a solution of whale oil soap and sal soda. It is stated that this saw will be used in cutting to size the armor plates for the United States Government war vessels which the company named has contracted to manufacture.

A Nightworker's Incandescent Electric Lamp, with an elastic band head-attachment, whereby it can be worn several hours without discomfort, is stated to have been devised by Mr. John H. Webster, of the Standard Refining Co., Boston. The light is said to be particularly adapted for the use of draughtsmen who have night-work to do, as it can be carried on the forehead, thus bringing the light directly over the work in any position assumed by the body. It will readily be perceived that there are a great many other occupations in which such a light would be extremely convenient. Of course, the usual flexible conductors are employed to supply the current.

A Neat Application of Magnetism to the solution of a simple mechanical problem has been made by Mr. Thos. N. Sterry of Norwich, Conn. In order to prevent rattling of car-windows, they are usually so closely fitted in the sashes, that the slightest swelling of the wood binds them, rendering their opening difficult and often impossible. Mr. Sterry obviates the need of such tight fitting by means of a permanent steel magnet fitted into the vertical edge of the sash, and a fixed iron bar fitted in the window frame. The magnet is a bar of considerable length, the ends of which are bent toward the face of the sash, the poles being thus brought into superposition on the fixed armature bar. The magnets have sufficient power to keep the sash from rattling by pressing the latter toward the armature bar or keeper; and as only the friction due to this pressure has to be overcome in raising the sash, this operation is very easily performed.

Of Compound Locomotives, Mr. Thomas Urquhart, M.Inst. C.E., M.I.M.E. Locomotive Superintendent Grazi-Tsaritzin Railway, Borisoglebsk, South Russia, writes to *Engineering*, London, as follows:

Knowing the interest taken in this subject at home and abroad, I am pleased to be in a position to inform you that since the first compounded locomotive was put into service in September, 1877, we have up to date compounded thirty-two locomotives, of three types, passenger, six-wheeled, and eight-wheeled coupled goods, having run in all over 1,000,000 engine miles in regular train service. The net economy during this service up to January, 1891, comes out at 18½ per cent. less consumption of liquid fuel, as compared with non-compounded locomotives of the same classes doing equal work, the compounding of other locomotives being pushed forward as quick as the limited means of our works will admit of it being done.

A "*Key to Steam Engineering*" is the title of a little catechism in a flexible cover published by E. B. Stillings & Co., 55 Sudbury Street, Boston, 1890, which the Mason Regulator Company is distributing to its patrons with the imprint of the company on the outside. The subject of the practical management of steam is well treated in the form of questions and answers, together with such theoretical points as are usually comprised in examinations of applicants for engineer's certificates.

The Shay Locomotive on account of its unique design and its great tractive power elicits much comment, some of it humorous yet expressive of the capabilities of the machine. The *Railroad Gazette* in its issue of May 8, gives a description of this machine a column of space and an inset bearing a handsome engraving well showing the peculiarities of the design. In opening its description the journal cited remarks that "an engineer who has had some experience with this novel locomotive, says that 'it can climb a tree and the only danger in using is that it may run into itself.'" As many of our mechanical readers have probably heard very little about it, its very peculiar construction will be of interest. It has 3 four-wheeled trucks, one well forward under the boiler behind the pilot; the others are arranged under the rear of the cab and under the tender, the whole being supported on a strong frame, and every wheel in the twelve being a driver. The cylinders are placed at right angles with the longitudinal axis of the machine, instead of parallel with it as in ordinary locomotives, and

apply their power to cranks on a longitudinal shaft running on one side from the rear truck wheels to the front ones. Each of the wheels on this side has a bevel gear on its outer face, into which the teeth of a smaller bevel wheel keyed to the longitudinal shaft meshes. The boxes of the axles are adjustable to provide for alignment as the axles wear. The longitudinal shaft has an expansible universal coupling which gives it flexibility in rounding curves. There are various other details, but we have given the main features of the construction. One of these locomotives has, on the Alleghany and Kruzua Railroad, run for some time on a grade of 264 feet to the mile, with 22 degree curves taking up two loaded 60,000 lb. cars. On the Crescent Mine Tramway, one of the Shay engines works on a grade of 549 feet to the mile. The *Railroad Gazette* sums up the advantages of this form of construction :

"Some of the advantages claimed for this engine are : Shortest possible rigid wheel base ; more uniform distribution of total weight over long wheel base, thus permitting the use of a powerful locomotive on a light rail ; sufficient flexibility of wheel base on curves of the shortest wheel base that an ordinary freight car can pass; utilization of entire weight of engine for adhesion and decreased cost of hauling at low speeds on heavy grades and sharp curves."

To Restore Tarnished Daguerreotypes may be in many cases extremely desirable when these are the only existing portraits of those whose likenesses are valued. Mr. W. H. Sherman in the *Photographic Times* says this may be quickly and perfectly done by immersing them in a hot solution of cyanide of potassium. Only good dry solid commercial cyanide is suitable, which has not been used for any other purpose. We quote the recipe.

"Dissolve about half an once of cyanide in a pint of water, and heat in a porcelain evaporating dish. Immerse the plate, face up, move the dish, continuing the heat until the color disappears, then remove the plate and wash it thoroughly under the tap. It can be dried by leaning it cornerwise and nearly upright in the top of a graduate, or in the old way by holding it at the corner with a pair of pliers, and heating it from the top downwards."

The Serve Ribbed Boiler Tubes recently tested at Elizabethport, N. J., for a period of six days, appear from published reports to have given surprisingly good results in evaporative efficiency,—so good that conservative engineers will perhaps wait for other trials before accepting them as conclusive. An evaporation of 100 lbs. of water, for 13.65 lbs. of coal, as an average result for six days running is quite beyond the ordinary evaporative efficiency of upright tubular boilers. However, it is precisely in this kind of boiler that the maximum gain ought to be expected from extended surface because, owing to their usually small fire surface as compared with grate area, the directness of the passage of gases to the uptake and the brevity of this passage, they are notably uneconomical of fuel. The gain in efficiency by the employment of the Serve tubes, is stated to have been nearly 31 per cent. over results obtained with the plain tubes. It may be questioned perhaps whether this proves the Serve tubes to be better than plain tubes, or demonstrates that the grate area is too large for the plain tubes. It does show, however, that when the Serve tubes are used, vertical tubular boilers may be made without the too common disproportion of fire surface to grate area.

Weldless Steel Chains are now made in England, by a very ingenious process. These chains are claimed, with two-thirds the weight of welded link chains, to have the full strength of the latter. The details of the process require engravings for their elucidation, but its general character may be briefly stated. A bar is first rolled to a four-rayed, star-shaped, cross-section having filleted reéntrant angles, and rounded points. At equal spaces longitudinally of the bar, pairs of holes are diagonally drilled entering and issuing at the reéntrant angles in such manner as to intersect each other at right angles. The projecting flanges of the bar are next notched by machinery midwise between the drilled holes. At this stage the bar has roughly the form of a flat-linked chain straightened out, but with the links all joined rigidly together. Several successive workings subsequently shape and

separate the links to form the finished flexible chain. The links when finished have the general form and cross-section of welded links made from round bar iron.

A Phenomenon in Friction forms the subject of a contribution to the *Journal of the Franklin Institute* for May, to wit: the fact that rotating journals or shafts rotating on their bearings may be slid endwise with much greater ease than when not rotating. Mr. John H. Cooper, the author of the article, discovered this fact while experimenting with the Thurston railroad testing machine. The phenomenon has been known many years, although Mr. Cooper, and presumably the editors of the magazine cited, thought it new as the article was printed without comment. The converse is also true, that a cylindrical shaft when sliding longitudinally in a hollow cylindrical bearing in which it has a working fit may be much more easily turned on its longitudinal axis than when at rest, and this may be generalized in the statement that a body sliding in one direction on a bearing surface may be moved on such a surface at an angle with the primary motion with much less power than when at rest. This really curious phenomenon, so far as known to the writer, has never been satisfactorily explained. It was first brought to his attention in 1869 in a conversation with Mr. A. K. Rider, then one of the engineers connected with the Delamater Iron Works in New York City, and the well-known inventor of the Rider cut-off. In fact, this principle is involved in the Rider cut-off, which is made variable by rotating on the axis of its valve-stem the cut-off slide fitted to a cylindrical seat on the back of the main slide valve, the cut-off edges of the slide being at acute angles with the axis of the valve-stem instead of at right angles, as in the ordinary slide on the back of a main valve, and the ports through the main valve being similarly inclined. As, however, Mr. Cooper has measured, in the case of the rotating car-axles tested, the exact power required for endwise movement the data he gives are valuable. He states that:

"The several boxes tried had about fourteen square inches of surface in contact with the axle; they were variously loaded, with weight from 262 pounds upwards, and the axle was running at speeds varying from 160 to 400 revolutions per minute. One box could be moved by a pressure of one ounce when the axle was running, but required thirty-two pounds to move it when the axle was still. Another box was moved by four ounces with motion, but required forty pounds without motion of the axle. A third box under considerable pressure could be moved readily by a pull of six ounces, but fifty pounds would not start it when the axle was still, and indeed, on trial, all the muscular force I could apply to it by my hands, with my foot against the machine, failed to start it."

Mr. Cooper states that to all who saw this phenomenon it was *new* as well as inexplicable, and that, while no one attempted to explain it, a suggestion was offered that the principle could be applied to planers with the result of a saving in power by substituting rotating shafts for the fixed Vs in the bed-ways, thus providing revolving ways for the guidance of the tables. There seems, however, to be many practical difficulties in carrying out such a suggestion.

Since writing the above we have seen an explanation of the phenomenon by Mr. Coleman Sellers of Philadelphia, which does not, however, seem to meet the case fully. It involves the law expressed in the parallelogram of forces, but in the writer's opinion, could only apply to bodies moving freely, without friction. It cannot be that the mere motion of a body in one direction annihilates a force opposing its motion in any other direction.

The Maxim Flying Machine with which it is proposed to make a practical trial is stated to be 110 feet in width and 40 feet long. These proportions are extraordinary, and it seems possible that the dimensions have been reversed inadvertently by the interviewer; but as Mr. Maxim is apt to take wide and original views of any subject to which he gives attention the statement may be correct.

CIVIL Service Reform in the U. S. Navy initiated by the order of Secretary Tracy for the vacation of all positions of foremen and Master Mechanics in the Brooklyn Navy-yard on June 1 (such positions to be hereafter filled in order of merit determined by competitive examination) and the appointment of a board of examiners for this purpose, is attracting attention and eliciting comment. It is evident that in spite of ridicule thrown upon it by many influential journals, civil service reform is here to stay. Those familiar with the Navy-yard methods as they have heretofore been applied to appointments must, unless absolutely blinded by prejudice, approve this action of the Secretary. The "Tite Barnacles" will be ousted from "soft" positions, and new nerve and brain will be infused into the service. This evidence that political influence is losing while civil service reform is increasing its grip, is a hopeful sign for the future of the Republic.

A Woolen Factory of 36,000 Spindles Run by Electricity has been established in the Alps, the water for impelling the turbines which drive the dynamos being derived from the melting snow which always affords a sufficient supply. The modern doctrine of the interconvertibility of forces is very curiously exemplified in this application of power. First, solar heat, acting upon the surface of the sea, is converted into work in raising large quantities of water, the vapor of which swept by winds over the cold summits of the Alps, is there condensed, congealed and deposited in the form of snow and ice. This plastic mass which contains an enormous potential energy, now acted upon by gravity, slowly forces its way down to a point of warmer temperature where it melts. Thus we have solar heat first performing work to store up potential energy which again is converted into the potential energy of falling water—the momentum of the falling liquid mass. A portion of this on reaching the turbines is converted into work again and this expended in turning the dynamos is converted into the force of electricity. This force, now carried by proper connections and applied to the turning of the machinery of the mill, is partly converted into heat by friction and partly into work, which is again partly converted into potential energy of the kind known as elasticity represented in the twist of the yarn, and otherwise consumed in ways that defy further pursuit.

Measures for the Prevention of Forest Fires are imperatively demanded. The annual losses from this source are enormous. No exact data for estimating the aggregate of these losses exist, but no one will question the statement because of such a lack. It would be interesting if it were possible, to determine the ratio of the destruction of timber by forest-fires, to the quantity cut and manufactured into lumber in the United States. No doubt it would surprise even those who have made the subject a study, so far as the imperfect data permit. The measures necessary to fully meet the exigencies of the case will probably tax engineering skill as well as legal and legislative ability; but, with a due regard to the preservation of our valu-

able timber, they cannot be longer postponed. Nothing in the above has been said of the damages to agricultural interests which very commonly accompany forest-fires, and these, as in the case of the recent fires in Michigan, are notable. The destruction of small frontier villages, is also too often to be included in the full consideration of the importance of the subject, to say nothing of the loss of human life which cannot be commercially estimated.

The Government Appropriation for the expenses of experiments in inducing rain-fall by explosions in the atmosphere has been the subject of adverse criticism almost culminating in ridicule in scientific circles; and the scheme of these experiments rests upon so slender a basis, when scientifically regarded, as to render it a matter of surprise that it ever was considered sufficiently important to entitle it to such action. The supposition that rain-fall has any immediate or approximate connection with the explosion of powder upon battle-fields has no more evidence to support it than a belief would have that it depended upon the smell of gunpowder, upon the flow of human blood, the groans of the wounded, or the flight of souls from mortal tenements destroyed in the carnage. To be scientific, the Government should reproduce all these conditions simultaneously as well as separately and in groups to ascertain with which one of them, or set of them, rain-fall is coincident. But it would be just as sensible to appoint a commission and spend money to determine the truth or falsity of the popular belief in a "wet" or a "dry moon," or to ascertain whether,—as it is generally asserted that it nearly always rains on moving days or election days—a drought could not be ended by a general transfer of household furniture, or by ordering a special election.

Of Keeley, the male Blavatsky of mechanical mysticism, and the most arrant impostor of the nineteenth century, the world has had enough, and more than enough. His meaningless jargon has been perpetrated *ad nauseam* and as it is neither fun nor sense, it is hard to perceive why the public tolerates it, or the press imposes it upon newspaper readers. There may be some excuse in the fact that many people whose pockets have suffered depletion through his wiles and guiles, are affected either by a gleam of hope, or a spasm of mortification whenever they see his name in print; but as the vast majority of people have come to the opinion that the once famous "Keeley Motor" never had any motive power that could do any work besides the disgorgement of surplus capital from the purses of dupes and that it has now lost even this capacity, they have little interest in Keeley and would like to have him and his pseudo science relegated to the category of insufferable bores.

The Ownership of Railroads by the State, as advocated by Mr. William T. Croasdale in the May number of THE ENGINEERING MAGAZINE, has been subjected to comment and criticism pro and con in various newspapers, as a sample of which comment we reproduce the following from the Buffalo *Courier*:

"A writer in THE ENGINEERING MAGAZINE who has been arguing in favor of the State ownership of railroads cites the Erie Canal to prove the practicability of his theory, whereat the Boston *Post* replies: 'The Erie Canal, during most of its period of State ownership, has been a source of corruption and extravagance, which augurs ill for State ownership.' And it further observes: 'With the Erie Canal as a warning before their eyes, it should be long before the people of this country adopted a scheme which involves in any degree "governmental operation."' The idea of using the canal as a frightful example of the evils of State ownership will strike everybody in the State with surprise and amusement. The *Post* will not make out much of a case if it confines its argument to the precedent of the canal."

The increasing refinement in office fittings, furniture, and appointments is attributed by the *National Real Estate Investor's Guide*, partly to the growing practice of employing women as office assistants; and there is, doubtless, much truth in this supposition. The mutual refinement of the sexes through association in schools has been ably maintained by prominent educators. Women are gradually finding the occupations to which they are adapted and which social and com-

mercial changes demand for them. Has any one given much thought to the truth that the enlarged field of employment is mainly due to progress in invention based upon progress in science? After all, science more than religion has been the primary cause of this amelioration in the status of women. As proof, the telegraph, telephone and typewriter are a sufficient mention.

Decidedly Adverse to the Tobacco Habit are the conclusions of Dr. Seaver — the physician of Yale College—who has been making carefully instituted and conducted comparisons of the physical condition of tobacco users and abstainers from tobacco in that old and honored institution. Dr. Seaver is not only a trained physician, but also a professor of athletics, and is also credited with ample knowledge of scientific methods and with having confined himself strictly to such methods in his investigation. He finds that the lung power as tested by the respirometer is less with the tobacco users than with the abstainers. They are also inferior in weight and height, and their muscular and nervous power is less in a marked degree. He also asserts that in intellectual power and in scholarship the smokers are much inferior. These statements will probably be challenged by tobacco users, but so far as we have seen, they are not yet disputed.

A Peculiarity of the Black Sea is stated by Professor Werkoff to be the quantity of sulphuretted hydrogen found in its waters. The proportion of this contained gas increases rapidly with the depth of the sounding whence it is drawn, being a mere trace at a depth of 450 feet, becoming very sensible at 600 feet, and so pronounced at 940 feet and at greater depths as to preclude the existence of animal life. He says that at the depth of 940 feet are found the remains of the Pontic fauna which inhabited the Black Sea at the pliocene epoch, when this basin, still separated from the Mediterranean, and with a depth of only 3000 feet, contained water of but feeble salinity. At the opening of the Bosphorus the waters of the Mediterranean would make their way into the Black Sea, and lead to the disappearance of the ancient fauna. The sulphuretted hydrogen, then, is only one of the products of the decomposition of these ancient organisms, the elimination of which takes place very slowly, owing to an immobility almost absolute of the water at a certain depth.

An Erroneous Statement which has been going about in the daily papers is that there are no flowering plants within the Arctic circle. This is a fair sample of many statements which, because they are short and make convenient and attractive items, are published without question and with little care whether they are true or false. Kane in his explorations found twenty families of phænogamous plants represented between 70° and 80° north latitude, as any one may see by consulting the appendix to his interesting narrative accessible in any good library. Some of the specimens found had even matured their fruit.

The Latest Thing in Wrecking Appliances has recently been exhibited in New York Harbor. It consists in the employment of hollow air-tight steel spheres internally braced and having a diameter of twenty feet. The spheres each have an inwardly opening valve at the top and an outwardly opening valve at the bottom by which, when filled with water, the latter can be displaced by the injection of air, at the rate, it is claimed, of forty barrels per minute. These spheres are provided with exterior iron bracing, towing chains and means of attachment to the vessel to be raised. They are, in use, filled with water and towed to the wreck. One at the bow and one at the stern are attached to the hull on the listed side by divers, and enough water is displaced from them to right the vessel. Then others sufficient to raise the wreck are attached and the entire vessel is raised near to the surface, while the spheres float at and upon the surface of the water. In this condition the wreck is towed to the nearest dry dock.

A Long and Very Interesting Marine Race was concluded this month by the arrival at the port of Boston of two Scotch sailing vessels, the *Ardencraig* (2072 tons) and the *Trafalgar* (1696 tons). The *Ardencraig* arrived on the 5th of May at

10 A. M., having sailed from Calcutta on the 10th of December, 1890. The *Trafalgar* starting from Calcutta on the 13th of December, reached High Land Light on the evening of the 8th of May. Probably a race of 11,000 miles between two sailing vessels never before was sailed with so little difference as a fraction of one day in the time made.

The First Piece of Cotton Flannel ever manufactured in the Southern States was recently produced in Charleston, S. C. Speaking of this the Boston *Journal of Commerce* says:

"It was as handsome a piece of goods as one would wish to see, and manufactured, too, at a cost of fully one cent per yard less than the same goods could be produced at the North. The truth is, we do not realize how fast that portion of our country is acquiring the art of making cotton goods. They are fast upon the heels of the North, and the only way we at the North can lead the procession and run our mills at a profit is to get into finer goods, goods that require more skill to make. Let us get ready to act accordingly."

Well, if the South has reached the point of making cotton flannel to perfection, there is no reason to suppose it will be content to rest at that point. The truth is the South has waked up (*very* wide awake, if you please) and she is not going to sleep again soon. Our New England friends had better keep this very patent truth in full sight.

Snow Breastworks have been made the subject of experiment in the Russian Army during the past winter, and the *Official Military Gazette* says it has been proved by these experiments that snow thrown up 6 feet thick is a perfect protection against bullets fired at 300 paces. If packed up solidly with spade, and trampled down somewhat firmly, a thickness of 5 feet is enough. If the face of this snow barrier becomes frozen hard 4 feet will suffice, while an outer crust of ice formed by pouring water over it will render the snow intrenchment impenetrable beyond 3½ feet.

The Problem of Navigating the Air has, at last, been taken up by exactly the right man who has gone about its solution in exactly the right way, and as he has an infinite fund of mechanical and inventive genius and is understood to have declared his purpose to succeed if he lives long enough, the world may expect results. We allude to Mr. Hiram J. Maxim, whose inventive genius has already won for him fame and fortune, and has reflected honor upon the land of his birth. This is what he is reported to have said: "If I can rise from the coast of France, sail through the air across the Channel, and drop half a ton of nitro-glycerine upon an English city I can revolutionize the world. I believe I can do it if I live long enough. If I die some one will come after me who will be successful where I failed." From reliable sources we gather that Mr. Maxim has arranged a very elaborate apparatus at Bexley, Kent, England, for conducting experiments on ærial navigation. The apparatus comprises a great number of instruments for investigating everything pertaining directly or indirectly to the subject. Under a large wooden canopy erected for the purpose he is carrying out these experiments. Already he is said to have produced motors that will yield a horse-power for every 6 pounds weight, and by a characteristically ingenious device he has been able to ascertain the sustaining capacity of a horse-power which he states to be 133 pounds. So now it is possible for 6 pounds weight in a motor to sustain besides itself 127 pounds in air, a power in proportion to weight very closely approaching (to say the least) that of the muscular mechanism of birds.

Statistics of Traffic compiled by the Keesport, Pa., *Times*, state that the traffic of the Suez canal which is open the entire year and to all countries, for 1890 was 3389 vessels, registerering 6,890,014 tons. The traffic of the Sault Ste. Marie canal, through which vessels reach the lower lakes from Lake Superior, was last year 10,557 vessels and 8,454,435 tons burthen, the canal being open only 228 days during the year. The *Times* derives from these figures an argument for the value of reciprocity with Canada which skirts nearly the whole region. The figures certainly convey a forcible impression of the magnitude and importance of our inland lake commerce, as compared with the general commerce of the world.

OUR EXCHANGE TABLE.

EDITORS and publishers are requested to send marked copies of special publications for mention in this department. The list of articles is still not so complete as we purpose to make it, for reasons that will readily suggest themselves.—ED.

ELECTRICAL ENGINEER: *w.* 10c. Chicago. April 25. Chicago Telephone Service. Proposed Electrical Building at the World's Fair. (Illust'd Supplement.) Electrical Department of the World's Fair. The Incandescent Lamp. Thomas G. Grier. May 2. Laying the Underground Conductors of the Minneapolis Street Railway. (Illust'd.) Electrical Department Demands for the World's Fair. Electricity in the Production of Aluminum. Alexander S. Brown.

THE PHOTOGRAPHIC TIMES: *w.* 15c. New York. May 15. Instruction for Beginners. The Rise and Fall of the Daguerreotype. (Cont'd.) W. H. Sherman. May 22. Conventionalism in Color. J. Howson.

MANUFACTURER'S RECORD: *w.* $4 per year. Baltimore. May 2. Norfolk, Va. The Coming Port of the South Atlantic. May 9. Norfolk's Cotton Trade. A Non-Acid Phosphate Fertilizer. May 16. Harbors on the Southern Coasts. A Suggestion to Owners of Mineral Property: Deposits should be Uncovered for Expert Examination. Gold and Silver Mining. Present Condition of the Mining Industry in the South. Florida Phosphates. Jay Schrader, Special Correspondent. Activity in Phosphate Mining.

ELECTRICAL REVIEW: *w.* 10c. New York. May 9. The Commercial Production and Application of Ozone. Ernst Fahrig. Stanley's Constant Potential Alternator. (Illust'd.) Electricity in Mill Work. Mr. O. S. Hussey. Wimhurst's Alternating Influence Machine. (Illust'd.) May 23. The Phonograph and the Micro-Graphophone as an Assistant to Medical and Other Sciences. Dr. J. Mount Bleyer.

THE ELECTRICAL WORLD: *w.* 10c. New York. May 16. A Promising Storage Battery System. (Illust'd.) Chronological History of Electricity, Galvanism, Magnetism and the Telegraph. B. C. 2637 to A. D. 1888. (Illust'd.) P. F. Motteley. Alternating Current Electric Motors. (Illust'd. Contin'd.) Dr. Louis Duncan. Johns Hopkins University. Prof. Ewing's Theory of Magnetism. (Illust'd.) Arthur Hoopes. May 23. The Electric Illumination of New York City's New Music Hall. (Illust'd.) Chronological Hist. (Cont'd.) Differential Gear for Electric Elevators. Report on the Electrical Transportation System of The New England Portelectric Company. Frankiin L. Pope. The Measurement of Power Given By Any Electric Current to Any Circuit. (Cont'd.) Prof. W. E. Ayrton and W. E. Sumpner. The Magnetic Circuit of Transformers.—Closed Versus Open. (Illust'd.) S. Evershed. Notes on the Design of Multipolar Dynamos. (Illust'd. Cont'd.)

ENGINEERING: *w.* 6d. London. April 24. The Transandine Railway Tunnelling Plant. (Illust'd) The Atlantic Records. (Cont'd). Modern French Artillery. (Illust'd and Concluded). The United States Cruiser *Yorktown*. The Strength of Riveted Copper Joints. (Illust'd.) The Jena Optical Glasses (Illust'd.) Fisk's Range-finder and Elevation Indicator. (Illust'd.) On Some Different Kinds of Gas Furnaces. (Illust'd.) Mr. Bernard Dawson. May 1. The Compressed Air System of Paris. (Illust'd. Cont'd.) The Jena Optical Glasses. (Concluded.) Boilers and Engines of the S. S. *Indra*. (Illust'd.) The Sims Edison Torpedo. (Illust'd.) Boiler Deposits. Prof. Vivian B. Lewes, F. C. S. F. I. C. Gas Furnaces. (Illust'd. Concluded.) Mr. Bernard Dawson. May 8. The Thames River Bridge. (Illust'd. Concluded.) Marine Engine Trials—Report of Trials of the S. S. *Iona*. (Illust'd.) May 15. The German Repeating Rifle.

(Illust'd.) Steam Boiler Experiments (Illust'd.) Mr. Bryan Donkin and Professor Kennedy. F. R. S. The Proposed New Railway to London. The Screw Steamer *Irene* with Sheerlegs on Deck. (Illust'd.) Railways for Coast Defense. The Steam Enginemakers Society. The New York Liners S. S. *Bourgogne and Gascogne*. (Illust'd.) The Strength of Short Boilers. J. C. Spence. The St. Louis Merchants' Bridge (Illust'd.) Steel for Artillery. On Tests of Steel used in the Manufacture of Artillery. W. Anderson, D. C. L., M. Inst. C. E.

AMERICAN MACHINIST: *w.* 6c. New York. May 21. Conveniences in the Machine Shop. Knock-off Motions for Steam Engines. W. H. Booth. The St. Louis Meeting of the American Boiler Manufacturers Association.

THE ENGINEERING NEWS: *w.* 12c. New York. May 9. The Brooklyn Water Works Extension. (With inset. Illust'd. Cont'd.) The Verrugas Viaduct. (Illust'd.) Vertical Lifts for Canals. (Illust'd.) Oscar W. Petri, Königlicher Regierungs-Baumeister in Magdeburg. May 16. Comparative Merits of Various Systems of Car Lighting. (Illust'd. Cont'd.) The New Ship-yard at Newport News, Va. (Illust'd.) Electric Transmission and Conversion of Energy for Mining Operations. (Illust'd. Cont'd.) Notes on English Railways. (Illust'd. Cont'd.) Locomotive Statistics for 25 Years, of the Chicago, Burlington and Quincy Railway. (Illust'd.) May 23. A Floating Floor Drawbridge. (Illust'd.) The Relative Economy of Cable, Electric and Animal Power for Street Railways. Improvements at the University of Pennsylvania. Comparative Merits of Various Systems of Car-lighting. (Illust'd. Cont'd.) Notes on English Railways. (Illust'd. Cont'd.) The Monier Method of Constructing Arches. (Illust'd). Vertical Lifts for Canals. (Illust'd. Concluded.) Oscar W. Petri. Water supply of Bombay, India. Tables for Finding Stresses in Parallel-chord Bridges, Uniformly Loaded, Having verticals and Equal Panels. Prof. H. A. Hitchcock, Thayer School of Engineering.

SCIENTIFIC AMERICAN SUPPLEMENT: *w.* 10c. New York. April 25. The Raising of the *Ulunda*. (Illust'd.) The Thermic Motor of the Future. (Trans. from *La Nature*, Illust'd.) The Power of Water or Hydraulics Simplified. (Illust'd. Cont'd.) G. D. Hiscox. Starches for the Finishing of Cotton Fabrics. (Illust'd.) May 2. The Spanish Cruiser *Pelayo*. (Illust'd.) The Physics of the Screw Propeller. John Lowe, Chief Eng. U. S. N. Photography in Aniline Colors. A. G. Green, C. F. Cross and E. J. Bevan. The Adoption of the Beam Trawl in the United States. (Illust'd.) E. C. Bryan. May 9. The First Ocean Steamer. (Illust'd.) F. L. Hagadorn. Ellipses and Equivalent Ovals of Equal Areas. Frederic R. Honey, Ph. B. May 16. Gold in Columbia. Edwin H. Prindle.

WESTERN ELECTRICIAN: *w.* 10c. Chicago. May 9. Process of Manufacturing Accumulator Grids. (Illust'd.) New Underground Conduit System. (Illust'd.) Substituting Electricity for Steam. (Illust'd.) Frank L. Perry. May 16. Utilizing the Water Power at Spokane. (Illust'd.) May 23. Central Union Passenger Station Electric Plant. (Illust'd.) Electric Light in the Royal Castle, Berlin. (Illust'd.)

RAILROAD GAZETTE: *w.* $4.20 per year. New York. May 1. The Adhesion of Railroad Spikes and Lag-Screws in Ties. (Illust'd.) Some Recent Baldwin Compound Engines. (Illust'd.) Electric Welding. Improvements in Locomotive Boilers. May 8. Tests of Fuel Saving Devices on French Locomotives. (Illust'd.) Early German Studies of American Railroads. (Cont'd.) Right of Way for Railroads. Julien A. Hall, M. Am. Soc. C. E. Phenomenal Friction. Coleman Sellers. New Forms of French Passenger Cars. (Illust'd.) The Length of Radius Bars. (Illust'd.) May 22. Wheel Weights of Heavy Locomotives. (Illust'd.) Interlocking at the Erie Terminus, Jersey City. (Illust'd.)

THE COLLIERY ENGINEER: *m.* $2 per year. Scranton, Pa. May. Ore Deposits—Classification—Mode of Occurrence—Theories of Origin—Popular Errors. (Illust'd. Cont'd.) H. A. Wheeler, E. M. The United Colliery Mine Fire. Wm.

West. Principles and Practice of Coal Mining on the Pillar Systems. (Illust'd. Cont'd.) W. S. Gresley, M. E. An Elementary Treatise on the Principles of Coal Mining. (Illust'd. Cont'd.) A. A. Atkinson.

JOURNAL OF ENGINEERING SOCIETIES: *m.* 30c. Chicago. April. An Enlarged Waterway Between the Great Lakes and the Atlantic Seaboard. E. L. Corthill. The Outlook for Local and General Engineering Societies. William H. Searles. Some Notes on Distribution Reservoirs. W. W. Curtis. A Simple Graphic Method for Determining Moment of Inertia. F. E. Turneaure.

THE RAILWAY MASTER MECHANIC: *m.* $1 per year. Chicago. May. Broken Piston Rods and The Laird Guide. (Illust'd.) William Forsyth. Deterioration of Steam Heating Hose. (Illust'd.) Inspection of Air-Brakes on Freight Cars. Angus Sinclair.

MANUFACTURER AND BUILDER: *m.* 15c. New York. April. Utilizing the Water Power at Niagara Falls. (Illust'd.) The Steam Loop. (Illust'd.) The Slide-Valve. (Illust'd.) Robert Grimshaw. The Sewage-Disposal System of Worcester, Mass. (Illust'd.)

JOURNAL OF THE FRANKLIN INSTITUTE: *m.* 50c. Philadelphia. May. Progress of Chemical Theory—Its Helps and Hindrances. Prof. Persifor Frazer. Riveted Joints in Boiler Shells. (Illust'd and concluded.) William Barnet Le Van.

POWER: *m.* 10c. New York. May. Transmission at the Electric Light and Power Station of the West End Street Railway Co. of Boston. (Illust'd.) The Dow Steam Turbine. (Illust'd.) Turning Engine Pulleys. (Illust'd.) Engine Foundations. (Illust'd. Cont'd.) A Thousand Horse Power Vertical Wetherill Engine. (Illust'd.) How to Measure Moisture in Steam. (Illust'd. Cont'd.) Prof. R. C. Carpenter, Cornell University.

THE RAILROAD AND ENGINEERING JOURNAL: *m.* New York, May. English and American Locomotives. Development of the Compound System in Locomotives. (Illust'd. Cont'd.) Precise Horizontal Measurement on Side Hills. Seth Pratt, C. E. Our Navy in Time of Peace. Lieutenant Henry Barroll, U. S. N. (Concluded) A Coffer-dam without Timber or Iron. Robert L. Harris, C. E. Natural Asphalt and the Preservation of Iron and Steel Structures.

MODERN LIGHT AND HEAT: *w.* $3 per year. Boston. May 16. On Imparting Electric Charges by Friction. Ed. Riecke. (Trans. from *Wied Ann.*)

ELECTRIC POWER: *m.* 20c. Electricity in the Production of Aluminum. (Illust'd.) Alexander S. Brown. Electric Applications to Organs. (Illust'd.) Electric Railway Construction (Illust'd. Cont'd). W. L. R. Emmet. Electricity in the French Navy.

THE AMERICAN SHIPBUILDER: *w.* New York. April 23. The Bath (Me.) Iron Works. (Illust'd.) May 21. The *Rhode Island's* New Compound Beam-Engine. (Illust'd.)

THE ELECTRICAL ENGINEER: *w.* 10c. New York, May 6. Experiments on the Ratio of Electrostatic to Electromagnetic Inductive Disturbance between Neighboring Telephone Circuits. (Illust'd. Cont'd.) A. E. Kenelly. Central Station Management and Finance. (Cont'd.) Horatio A. Foster. Oil as an Insulator for High Potentials. (Illust'd. Cont'd.) Notes on the Design of Multipolar Dynamos. W. B. Esson. May 13. A Chart of Standard Electrical Diagrams and Signals. (Illust'd.) Francis B. Crocker. The Patten Improved Alternating Current Motors. (Illust'd.) F. Jarvis Patten. Hydrochloric Acid in Bichromate Batteries. Charles Steinmetz. Central Station Management and Finance. Horatio A. Foster. Experiments on the Ratio of Electrostatic to Electromagnetic Inductive Disturbance between Neighboring Telephone Circuits. (Cont'd.) The Electrical Transmission and Conversion of Energy for Mining Operations. (Illust'd.) H. Ward Leonard. May 20. A New Way of Measuring Insulation Resistance. George W. Patterson, Jr. Submarine Cables in Shallow Waters —What they have to Put Up With. (Illust'd.) Herbert Laws Webb.

THE ENGINEERING AND MINING JOURNAL. *w.* 10c. New York, May 2. Interesting Occurrences of Gold. A. Haussman.

The New Quebec, Mining Law. R. W. Raymond. Common Uses of the Rare Elements. Elwyn Waller, Ph. D. Fire-Proof Mill Construction. Methods of Quarrying, Cutting and Polishing Granite. Wm. C. Day. The Moebius Electrolytic Parting Process at Pinos Altos. (Illust'd.) Geo. W. Maynard. New Specific Gravity Tables for Hydrochloric and Nitric Acid. (Illust'd.) Prof. G. Lunge, Ph. D. Polytechnic School Zurich. May 16. Performance of Seventy-five Ton Refrigerating Machine of the Ammonia Compression Type. (Illust'd.) Prof. J. E. Denton, Stevens' Inst. Experiments in Zinc Desilverization. H. Rossler and B. Edelman. The Mica Industry of the United States. L. J. Childs. May 23. Performance of Seventy-five Ton Refrigerating Machine of the Ammonia Compression Type. J. E. Denton. (Illust'd. Concluded.) Chemical Investigations of the Blast Furnace Process. A Ledebur. Trans. from *Handbuch der Eisenhuttenkunde.* (Cont'd.) Casting Solid Ingots. (Illust'd.)

STONE: *m.* $2 per year. Indianapolis, May. Glacial Boulders for Building Purposes. New Circular Diamond Stone Saw. Trans. from *La Nature.* (Illust'd.) Evolution of Memorial Art. (Illust'd.) O. A. Coltman. Man of the Stone Age. Bedford or Oolitic Limestone. Practical Stonecutting. (Illustrated. Cont'd.) D. F. Kennedy. Notes on Quarrying. William L. Saunders.

BOSTON JOURNAL OF COMMERCE: *w.* 6c. Boston, May 9. Calculations of Weight Necessary of Each Separate Count to Form a Given Quantity of Twisted Yarn. Racks and Pinions. Some of the Forms That May Be Produced. (Illust'd.) Jet Condensers. An Essay on Finishing Woolen and Worsted Textiles. (Cont'd.) Geo. Damon Rice, Jr. May 16. Oriental Carpets. Victor Turbines and Methods of Applying them to Tranmission of Power. (Illust'd.) Racks and Pinions.

STREET RAILWAY REVIEW: *m.* 15c. Chicago. May. Shall New Street Railway Stock be sold at Public Auction?—Address of Henry Whitney before the Massachusetts Legislative Committee on Cities. Rapid Transit in New York City. T. G. Gribble (Illust'd. Concluded.) A Tale of Three Cities and The Electric Bands Which Unite Davenport, Rock Island and Moline. Street Railway Law. Joseph Tuthill, M. D., V. S. Construction and Equipment Notes. (Illust'd.) A New Method of Constructing Electric Railway Conduits. (Illust'd.) The New Clyburne Ave., Cable Line, Chicago. (Illust'd.)

ELECTRIC RAILWAY ADVERTISER: *m.* $1 per year. Boston. May. Rapid Transit in London. A. Reckenzaun.

THE RAILWAY REVIEW: *w.* $4 per year. Chicago. May 9. Six-Wheel Switcher. Illinois Central Railroad (Illust'd.) Export of the Lackawanna Live Stock Express Co. by the Interstate Commerce Commission. The Drainage of Roadbeds. (Illust'd.) Development in Compressed Air Motors for Tramways. (Illust'd.) D. S. Jacobus. Saving in Material Stocks.

SCIENCE: *w.* 10c. New York. May 15. The Brooklyn Institute Biological Laboratory. The Etiology of Tetanus. Fermentations of Milk and their prevention. H. W. Conn. American and European Meteorology. H. A. Hazen. May 22. The Teaching of Scientific Method. Prof. Henry E. Armstrong.

THE IRON AGE: *w.* 10c. New York. May 7. Casting in Bronze (Illust'd.) An Assistant Cylinder for Marine Engines. David Joy. May 16. Sparrow's Point Blowing Engines. (Illust'd.) An English Critic on American Iron Manufacture.

THE STREET RAILWAY JOURNAL: *m.* 35c. New York. May. The Edison New Single Reduction Street Car Motor. (Illust'd.) Vertical Engines for Cable Railway Stations. (Illust'd.) Construction and Operation of Cable and Electric Railways. H. M. Kebby, C. E. Rapid Transit Plans for New York City—Communication to the New York Rapid Transit Commission. T. G. Gribble, C. E. (Illust'd.)

THE STREET RAILWAY GAZETTE: *m.* 25c. Chicago. May. All Steel Electric Trucks. (Illust'd.) Composite Girder Rails. (Illust'd.) A New Trolley Wire Insulator (Illust'd.) Jenney Motor Applied to a Hydraulic Pump. (Illust'd.) Statistical Proof of the Value of Street Railway Investments.